DOCUMENT RESUME

ED 106 732 CG 009 793

AUTHOR	Roebuck, Flora N.; Aspy, D. N.
TITLE	Response Surface Analysis. National Consortium for Humanizing Education, Interim Report No. 3.
INSTITUTION	National Consortium for Humanizing Education, Monroe, La.
SPONS AGENCY	National Inst. of Mental Health (DHEW), Rockville, Md.
PUB DATE	74
NOTE	112p.; For related documents, see CG 009 796, 797, and 799
EDRS PRICE	MF-$0.76 HC-$5.70 PLUS POSTAGE
DESCRIPTORS	Behavior Change; *Classroom Environment; *Interaction Process Analysis; *Interpersonal Relationship; Research Projects; *Response Mode; *Student Teacher Relationship; Teaching Methods
IDENTIFIERS	*National Consortium for Humanizing Education

ABSTRACT

One of the major studies conducted by the Consortium involved examining the inter-relationships of various aspects of teacher and student classroom functioning to determine what happens to a particular class of teacher or student behavior as the quantity and/or quality of other aspects of classroom interaction change. This examination occurred in two steps: (1) determination of the most powerful predictors from among the study variables for each of the behaviors, and (2) construction of response surfaces for each variable. Response Surface Analysis was carried out for each of the 25 study variables. Monthly audio tape recordings of an hour's classroom instruction from each of the participating teachers were coded for teacher and student behavioral variables. Some of the findings of the study were: (1) replicable, predictable, and significant relationships were detected among variables of teacher and student classroom functioning; (2) these relationships were different for the secondary and elementary school levels; (3) two of the four most frequently recurring predictors were variables which had been postulated by Rogers as being positively related to effective learning environments; and (4) most of the frequently recurring predictors were related to the kinds of behavior classified by Flanders as "Indirect." (Author/PC)

PERMISSION TO REPRODUCE THIS COPYRIGHTED MATERIAL HAS BEEN GRANTED BY
Flora D. Roebuck
TO ERIC AND ORGANIZATIONS OPERATING UNDER AGREEMENTS WITH THE NATIONAL INSTITUTE OF EDUCATION. FURTHER REPRODUCTION OUTSIDE THE ERIC SYSTEM REQUIRES PERMISSION OF THE COPYRIGHT OWNER

ED106732

RESPONSE SURFACE ANALYSIS

Interim Report No. 3
National Institutes of Health
NIMH Grant No. 5 PO 1 MH 19871

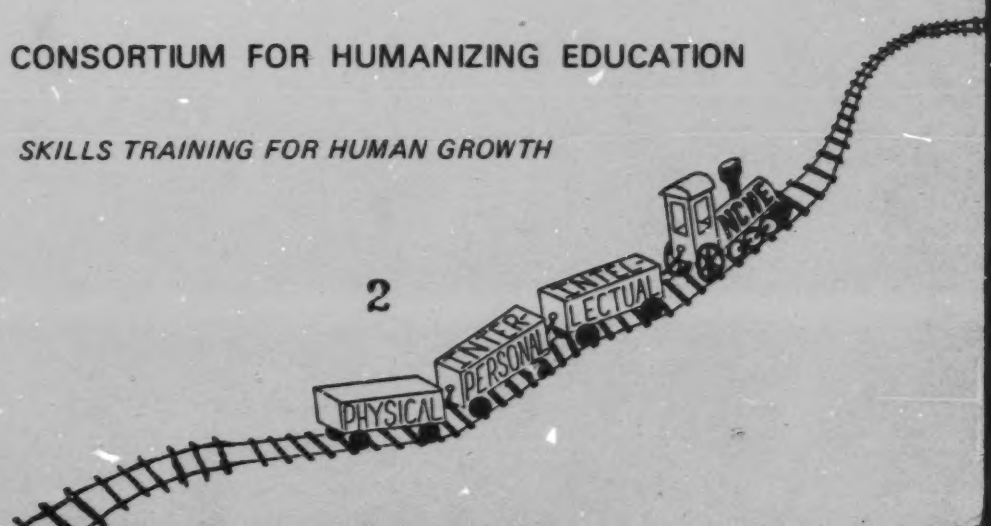
by

F. N. Roebuck
D. N. Aspy

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

NATIONAL CONSORTIUM FOR HUMANIZING EDUCATION

SKILLS TRAINING FOR HUMAN GROWTH



2

CG009198

ED106732

RESPONSE SURFACE ANALYSIS

by

Flora N. Roebuck
David N. Aspy

Interim Report Number 3

of the

NATIONAL CONSORTIUM FOR HUMANIZING EDUCATION

Northeast Louisiana University

Monroe, Louisiana

1974

The research reported here was supported in part by NIH Research Grant # P0 1 MH 19871 from the National Institute of Mental Health

Copyright 1974 Flora N. Roebuck

ACKNOWLEDGMENTS

In carrying out Response Surface Analysis, more than 100 hours of full-core computer time was utilized. We want to thank Dr. George T. Walker, President of Northeast Louisiana University, for authorizing this extent of support by the University to the project. We would also like to thank Dr. Hubert Tolman for the many midnights he worked in order to make this many hours of full-core usage available for our processing.

We are also taking this opportunity to express our gratitude to Mrs. Shirley Lamb, Research Secretary for the project. Shirley received, catalogued, routed through rating, initiated the computer accession process, checked for completion, and filed more than 4,000 tapes from teachers. In addition, Shirley received, catalogued, and routed from manual name-check to final computer accession all the sets of test and classification data for 700 teachers and 20,000 students. All in all, she kept track of more than 140,000 pieces of information. And yet, on any day during the project when we asked her questions such as,"What's the status of the 1st grade, Year 01, fall CTMM scores?", she had the answer at her fingertips. Her accuracy and painstaking attention to detail added immensely to the smooth functioning of the project.

F. N. Roebuck
D. A. Aspy

TABLE OF CONTENTS

	Page
INTRODUCTION	1
DESIGN	1
Study Variables	1
Samples	3
PROCEDURE	3
Samples of Instruction	3
Assessment of Study Variables	7
Degrees of Freedom	7
RESULTS	11
From Regression Analysis	11
From Construction of Response Surfaces	19
DISCUSSION	21
SUMMARY	24
APPENDIX A	25
APPENDIX B	77

RESPONSE SURFACE ANALYSIS

One of the major studies conducted by the National Consortium for Humanizing Education was that of examining the inter-relationships of various aspects of teacher and student classroom functioning to determine what happens to a particular class of teacher or student behavior as the quantity and/or quality of other aspects of classroom interaction change. This examination occurred in two steps: (1) determination of the most powerful predictors from among the study variables for each of the behaviors and (2) construction of response surfaces for each variable.

DESIGN

Response Surface Analysis was carried out for each of the 25 study variables (described below). The procedure used was to designate each of the study variables in turn as the dependent variable with the remaining variables being considered as independent. The computer was then loaded with the linear, quadratic, and cross-product values of the independent variables and backward elimination multilinear regression analysis was carried out. The procedure was continued until only two variables were left in the model. The resulting regression equation was used to generate points with which to plot the response surface. The regression equation with 3-variables was also identified and a 3-variable response surface was generated.

The analysis was carried out separately for elementary (grade 1-6) and secondary (grade 7-12) teachers as it was anticipated that the relationships would be different at the two levels. Three samples at each level were analyzed. (Since each sample consisted of the data obtained from Consortium participants in one of the three years of the study, the samples are labeled respectively Year 01, Year 02, and Year 03).

Study Variables

The Consortium obtained monthly audio tape recordings of an hour's classroom instruction from each of its participant teachers. These recordings were then coded for teacher and student behaviorial variables by teams of trained raters who maintained interrater reliabilities of above .90.[1]

---

[1]Roebuck, F. N.; Aspy, D. N.; Sadler, L. L. And Willson, M. A. Maintaining Reliability in a Longitudinal Study: Interim Report #1. Monroe, LA: National Consortium for Humanizing Education, Northeast Louisiana University (National Institute of Mental Health Research Grant No. 5 P0 1 MH 19871), 1974.

The raters apply three instruments in their coding of the recordings. The first instrument is a set of 5 Process Scales[2] adapted from Carkhuff[3] which utilize the teacher's vocal tone, choice of emotion words, and selected portions of the communication pattern to measure the level of interpersonal skills occurring in verbal interaction.

Each scale defines five levels from 1.0 to 5.0 with intermediate ratings beyond the decimal point; e.g., 1.3 or 4.7. In effect, then, each is applied as a 40 point scale.

The five interpersonal skills measured by the Process Scales are:

1. Meaning -- the teacher's empathy or understanding of the meaning-to-the-student of his classroom experiences.

2. Genuineness -- the teacher's person-to-person basis for interactions with students.

3. Success Promotion -- the degree to which the teacher promotes the student's attainment of his individual goals in moment-to-moment processes.

4. Respect -- the teacher's regard for the student as an individual with the capacity for achieving.

5. Student Involvement -- the degree to which the students are involved in and excited about their learning activities.

The raters also apply the Cognitive Functioning Categories developed by Aspy.[4] This is a time-sampling technique for measuring the frequency of occurrence of 8 categories of mental operations as they are indicated by teacher-student verbal products in the classroom. Four of these categories are for teacher products and four are for student products. The instrument further includes two categories for behavior which can not be codified as to its cognitive level.

---

[2] Aspy, D. N. Toward a Technology for Humanizing Education. Champaign, Illinois: Research Press, 1972.

[3] Carkhuff, Robert R. The Development of Human Resources. New York: Holt, Rinehart and Winston, 1971.

[4] David N. Aspy, op. cit.

The third instrument applied, Flanders' Interaction Analysis,[5] is also a time-sampling technique which supplies the frequency of occurrence in seven categories of teacher behavior, two categories of student behavior, and one category of silence or confusion. Flanders' Interaction Analysis is the most widely known of the instruments used by the NCHE. Table 1 lists all of the study variables and the symbols for each variable.

Samples

The teachers involved in the Year 01 (1971-72 school year) and Year 02 (1972-73) samples were "informed consent" participants from eight elementary schools, two junior high schools, and two senior high schools in a large city in north-central Texas. The schools represented all socio-economic levels and racial distributions in the city. The teachers in the Year 02 (1973-74) sample were "informed consent" participants from ten schools in a rural and suburban parish in northeastern Louisiana. They represented all but one of the schools in the Parish. Table 2 displays the distribution of the teachers in the three samples by race, sex, level, and years of teaching experience.

PROCEDURE

Samples of Instruction

Each teacher recorded one continuous hour of instruction during a designated week each month for at least 5 months during the year. The teachers had been directed to teach in their normal manner. These audio recordings were forwarded to the National Consortium for Humanizing Education where they were evaluated blind by trained raters. Table 3 displays the resultant data base in terms of the number of teachers participating and the number of hours of instruction coded by the raters.

Four 3-minute segments from each of the tapes were selected at random for evaluation. The first segment was taken from the beginning of the hour, the second segment from about twenty minutes into the hour, the third segment from about forty minutes into the hour, and the fourth segment towards the end of the hour.

---

[5]Flanders, N. A. Teacher Influence, Pupil Attitudes, and Achievement. U. S. Department of Health, Education, and Welfare, Cooperative Research Monograph #12. Washington, D.C.: Government Printing Office, 1965.

Table 1: Study Variables

Instrument	Variable Name	Abbreviation	Equation Symbol
Flanders' Interaction Analysis Categories	Teacher Accepts Feelings of Student	F-1	F1
	Teacher Praises or Encourages Student	F-2	F2
	Teacher Accepts Ideas of Student	F-3	F3
	Teacher Asks Questions	F-4	F4
	Teacher Lectures	F-5	F5
	Teacher Gives Directions or Commands	F-6	F6
	Teacher Criticizes or Justifies Authority	F-7	F7
	Student Responds	F-8	F8
	Student Initiates	F-9	F9
	Silence or Chaos*	F-10	F0
Cognitive Functioning Categories	Teacher Recalls Facts	C-1	C1
	Teacher Asks for Facts	C-2	C2
	Teacher Thinks	C-3	C3
	Teacher Asks for Thinking	C-4	C4
	Student Recalls Facts	C-5	C5
	Student Asks for Fact	C-6	C6
	Student Thinks	C-7	C7
	Student Asks for Thinking	C-8	C8
	Non-Cognitive Behavior	C-9	C9
	Silence or Chaos*	C-10	C0
Process Scales	Meaning	M	M
	Genuineness	G	G
	Success Promotion	SP	SP
	Respect	R	R
	Student Involvement	SI	SI

*NOTE: Although these variables have the same name, they are not identical because some behaviors which register in F-10 on the Flanders instrument are redistributed among categories C-5 through C-9 the Cognitive instrument.

Table 2: Distribution of Teachers within Samples by Race, Sex, Level of School, Years of Teaching Experience, and Location

	CLASSIFICATION	SAMPLES Yr. 01	Yr. 02	Yr. 03
Race	Total Black	62	43	36
	Total White	195	146	62
	Total Other	3+	3+	1*
Sex	Total Male	34	19	14
	Total Females	226	173	85
Sex & Race	Black Males	11	6	6
	White Males	23	13	8
	Black Females	51	37	30
	White Females	172	133	54
	Other Females	3+	3+	1*
Level	Elementary (grades 1-6)	162	132	55
	Secondary (grades 7-12)	98	60	44
	Total (grades 1-12)	260	192	99
Teaching Experience	1 Yr Experience	25	24	18
	2 Yrs. Experience	19	10	13
	3 - 7 Yrs. Experience	50	32	29
	8 - 15 Yrs. Experience	65	45	19
	16 - 25 Yrs. Experience	59	46	13
	Over 25 Yrs. Experience	42	35	7
	Location	Urban Texas	Urban Texas	Rural LA

+Sample included 1 American Indian female, 1 Mexican-American female, and 1 Oriental female.

*Sample included 1 Mexican-American female.

TABLE 3: DATA BASE

	ELEMENTARY			SECONDARY		
	Yr. 01	Yr. 02	Yr. 03	Yr. 01	Yr. 02	Yr. 03
No. of Teachers	162	132	55	98	60	44
No. of Hours of Instruction Coded	1,194	974	322	607	376	225

Assessment of Interpersonal Processes:

The teacher's levels of skills in interpersonal functioning were assessed blind by raters who applied the Process Scales. Each of the raters completed their evaluations separately. The inter-rater reliabilities for the scales ranged from .898 for Respect to .921 for Student Involvement.

Each of the four 3-minute segments selected from each tape was assigned a rating for each scale. The final measurement for each scale was the mean of ratings for the four segments for that scale. This mean for each scale was the score used in the data analysis. Table 4 displays the parameters of the data obtained from the Process Scales.

Assessment of Flanders' Interaction Analysis:

All four 3-minute segments for each tape were coded by trained raters using Flanders' Categories for Interaction Analysis. Coding occurred at 3-second intervals. Inter-rater reliabilities were above .96. The data used in the analysis was the total number of 3-second intervals recorded in each category for the tape. Table 5 displays the parameters of the data obtained from Flanders' Interaction Analysis.

Assessment of Cognitive Functioning:

All four 3-minute segments for each tape were coded by trained raters using the Cognitive Functioning Categories. Coding occurred at 3-second intervals. Inter-rater reliabilities were above .94. The data used in the analysis was the total number of 3-second intervals recorded in each category for the tape. Table 6 displays the parameters of the data obtained from the Cognitive Functioning Categories.

Degrees of Freedom:

Because there were multiple observations (tapes) of the same individual in each sample, a conservative estimate of significance was felt to be necessary. Therefore, the degrees of freedom in each analysis were based on the number of teachers in the sample rather than the number of observations. (See Table 3 to compare number of teachers and observations).

Table 4: PARAMETERS OF DATA OBTAINED FROM RATING WITH PROCESS SCALES

	ELEMENTARY TEACHERS (GR. 1-6)						SECONDARY TEACHERS (GR 7-12)					
	Yr. 01		Yr. 02		Yr. 03		Yr. 01		Yr. 02		Yr. 03	
	$\bar{x}$	$\hat{\sigma}$	$\bar{x}$	$\hat{\sigma}$	$\bar{x}$	$\hat{\sigma}$	$\bar{x}$	$\hat{\sigma}$	$\bar{x}$	$\hat{\sigma}$	$\bar{x}$	$\hat{\sigma}$
Mng.	2.75*	.22	2.61	.20	2.71	.18	2.70	.22	2.58	.22	2.66	.17
Gen.	2.74	.22	2.59	.20	2.72	.19	2.71	.22	2.57	.22	2.67	.17
S. P.	2.76	.23	2.62	.22	2.74	.19	2.74	.23	2.60	.23	2.68	.18
Resp.	2.81	.22	2.65	.19	2.79	.17	2.78	.22	2.63	.23	2.73	.18
S. I.	2.88	.19	2.81	.19	2.95	.12	2.80	.22	2.73	.22	2.88	.11

*Data reported is average of ratings on four 3-minute segments selected at random from a 1-hour tape.

Table 5: PARAMETERS OF DATA OBTAINED FROM FLANDERS INTERACTION ANALYSIS

	ELEMENTARY TEACHERS (GR. 1-6)						SECONDARY TEACHERS (GR. 7-12)					
	Yr. 01		Yr. 02		Yr. 03		Yr. 01		Yr. 02		Yr. 03	
Variables	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
F-1	0.05*	0.14	0.23	0.97	0.07	0.16	0.09	0.18	0.26	1.21	0.13	0.34
F-2	2.17	1.74	2.11	2.27	2.17	2 63	0.62	0.77	0.67	0.76	1.19	1.86
F-3	1.53	1.29	0.48	0.76	0 25	0.49	1.15	1 24	0.33	0.63	0.33	0 48
F-4	26.82	9.99	21.13	8.32	17 59	8.95	15.53	8.71	13.24	7.97	12.78	10.68
F-5	75.45	24.48	83.91	25.34	88.07	26.63	108.75	35.28	111.76	36.69	102.58	29.09
F-6	8.18	4.53	8.03	4.80	9.19	5.77	4.37	4.01	3.43	2.50	5.62	9.13
F-7	1.19	1.60	1.34	1.56	1.53	2.15	0.67	1.33	0.50	0.85	0.32	0.46
F-8	85.24	28.11	68.45	27.17	58.22	27.79	56.76	35.94	45.75	30.97	45.35	30.30
F-9	7.76	6.69	22.14	14.23	13.05	10.17	13.72	10.34	24.67	17.07	13.39	10.03
F-10	31.60	16.35	32.18	16.84	49.86	24.62	38.33	32.03	39.40	26.73	58.31	37.95

*Data is reported as total number of 3-second intervals coded in category during 12 minutes selected at random in four 3-minute segments from a 1-hour tape.

Table 6: PARAMETERS OF DATA OBTAINED FROM CODING COGNITIVE FUNCTIONING CATEGORIES

	ELEMENTARY TEACHERS (GR. 1-6)						SECONDARY TEACHERS (GR. 7-12)					
	Yr. 01		Yr. 02		Yr. 03		Yr. 01		Yr. 02		Yr. 03	
	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	$\hat{\sigma}$	$\bar{x}$	$\hat{\sigma}$
C-1	87.45*	23.93	91.33	26.65	97.91	25.58	113.92	33.66	114.41	35.77	104.90	25.92
C-2	26.28	9.25	21.01	8.09	15.68	7.22	15.01	8.31	13.32	8.17	11.79	10.54
C-3	0.20	0.59	0.19	0.56	0.16	0.51	0.52	1.14	0.63	1.18	0.18	0.32
C-4	1.51	1.88	1.56	1.58	1.36	1.50	1.10	1.69	1.47	1.99	1.22	2.02
C-5	86.46	25.81	86.68	31.33	67.19	26.21	62.40	34.25	62.59	38.31	57.28	27.61
C-6	0.94	1.16	0.95	1.07	1.86	2.53	3.28	2.87	2.48	2.06	2.13	1.74
C-7	3.11	4.28	2.64	3.35	1.94	2.30	3.15	4.50	3.82	4.68	1.86	3.40
C-8	0.26	0.67	0.19	0.86	0.14	0.54	0.51	0.82	709.01	0.38	0.13	0.46
C-9	2.74	3.03	3.41	2.82	3.85	4.00	2.65	3.14	3.38	7.20	3.79	4.46
C-10	31.07	16.06	32.03	16.69	49.92	24.52	37.45	31.14	37.74	25.29	56.70	35.08

*Data is reported as total number of 3-second intervals coded in category during 12 minutes selected at random in four 3-minute segments from a 1-hour tape.

RESULTS

From Regression Analysis:

A backward elimination regression analysis (as described in the section under design) was carried out for each of the 25 study variables in each of three samples for each of two school levels, making a total of 150 analyses conducted. The results are displayed in Tables 7, 8, and 9. The achieved multiple correlation with three variables remaining in the equation and the names of the 1st, 2nd, and 3rd best predictor variables are displayed for each of the dependent variables in each sample in Table 7 (for Elementary school data) and Table 8 (for Secondary school data). Table 9 displays the observed F for each regression and the level of significance. In the four cases where no clearly identifiable third variable was detected, the F's and levels of significance displayed are for the 2-variable equations.

A majority of the regressions were significant at $p < .001$; however, they ranged as high as $p < .75$. Acceptable level of significance was considered as $p < .05$. Only 19 of the 150 regressions failed to achieve this level of significance. Sixteen of these 19 regressions were scattered among the variables. The other 3 were concentrated in F-7 (at the Secondary School level) which failed to reach acceptable levels in all samples.

The varying levels of R^2 presented in Tables 7 and 8 indicated that some variables are predictable at approximately the same levels of R^2 from sample to sample while other variables show wide differences in achieved R^2 among samples. A methodical comparison of these R^2's provided an estimate of the stability of predictability of the study variables from sample to sample. A variable was considered to be <u>stable</u> in predictability if the achieved R^2 for none of the samples varied by more than <u>one-fourth</u> the mean of the R^2's for the three samples. It was considered <u>unstable</u> if any one of the R^2's varied by more than <u>one-half</u> the mean of the R^2's. Variables falling between these two extremes were not characterized as to stability. The results of the comparison are presented in Table 10.

As expected, consistency of predictability from sample to sample was associated with both ample R^2 and acceptable levels of significance; however, some variables with low R^2 were both significant and consistent from sample to sample while some variables with ample R^2 were neither consistently significant nor consistently predictable. It must be kept in mind, of course, that sample size is a contributor to the results displayed in Table 10. Another factor which must be considered is the small observed frequencies of some of the variables (see Tables 4, 5, 6). Of particular concern here are those variables in which the standard deviation is larger than the mean, indicating that there are many instances in which there are no occurrences of behavior in this category for a particular individual.

Table 7: Summary of R^2 and Predictive Variables from 75 Multilinear Backward Elimination Regression Analyses for Three Samples of Elementary Teachers (Grades 1-6)

Depend. Var.	Year 01				Year 02				Year 03			
	R^2	Predictors			R^2	Predictors			R^2	Predictors		
		1st	2nd	3rd		1st	2nd	3rd		1st	2nd	3rd
F-1	.20	C7	M	F9*	.01	F9*	M	⊠	.28	F9*	C7	S1
F-2	.26	C2*	M*	SI	.39	C2*	M*	SI	.44	C2*	M*	C5
F-3	.26	C2	SI*	C7*	.07	SI*	C7*	M	.40	C7*	SI	C4
F-4	.28	C6*	R	C5	.41	C5	C7	C6*	.35	C7	C6*	R
F-5	.56	C5*	R	⊠	.62	C3	C5*	C7	.41	C5*	R	C3
F-6	.15	C1	M	C2	.13	SI	C1	M	.21	F2	C2	SI
F-7	.11	C1*	M*	C2*	.26	C1*	M*	C2*	.26	M*	C2*	C1*
F-8	.20	F7*	R*	C2	.20	F7*	R*	C2	.10	F7*	R*	F2
F-9	.23	F1	M*	F3	.27	M*	SP	C2	.10	C2	M*	F2
F-10	.57	F8	C1*	⊠	.34	SI	C1*	C2	.54	C2	C1*	SI
C-1	.14	C8*	M	R	.05	C6	C8*	M	.11	C6	C8*	R
C-2	.84	F4*	C7*	M	.83	F4*	C7*	R	.84	F4*	M	C7*
C-3	.07	F2	F5*	C8*	.57	F5*	C8*	C	.07	C8*	F5*	F2
C-4	.62	C7*	F4*	M*	.73	C7*	F4*	M*	.63	C7*	F4*	M*
C-5	.62	C1	R*	F4	.21	F7	F4	R*	.07	F7	R*	C3
C-6	.11	F4	SI	F8	.07	F6	SI	⊠	.49	F8	F4	F3
C-7	.55	F8	C4*	M	.61	C4*	SP	F3	.52	F8	C4*	SP
C-8	.17	M	SI	C3	.76	C3	C4	F1	.09	C4	M	SI
C-9	.24	F1	F7*	M*	.32	M*	F7*	F3	.51	F7*	M*	F1
C-10	.29	C4	SI*	M	.37	F5	SI*	C4	.44	F5	SI*	F6
MNG.	.63	F2*	R*	C7	.86	F2*	R*	F3	.86	R*	F2*	C1
GEN.	.65	F2*	F7	SP	.96	F7	M	F2*	.95	M	F2*	C3
S.P.	.58	F2	C4	R	.93	M	C1	C4	.88	M	F2	C1
RESP.	.78	G*	C7	F3	.84	G*	C7	F3	.83	G*	F1	C7
S.I.	.67	G*	F1	C7	.75	G*	C7	C2	.63	G*	F1	C4

▨ Random (Non-Recurring) Independent Variable.

□ Recurred as predictor of dependent variable in 2 out of 3 samples.

▣ Recurred as predictor of dependent variable in all 3 samples.

⊠ No 3rd predictor identified; R^2 is for 2-variable equation.

Table 8: Summary of R^2 and Predictive Variables from 75 Multilinear Backward Elimination Regression Analyses for Three Samples of Secondary Teachers (Grade 7-12)

Depend. Var.	Year 01 R^2	Year 01 Predictors 1st	2nd	3rd	Year 02 R^2	Year 02 Predictors 1st	2nd	3rd	Year 03 R^2	Year 03 Predictors 1st	2nd	3rd
F-1	.13	C7*	M	SI	.10	F1	C7*	F2	.67	C7*	M	SI
F-2	.12	C7	SI*	C5	.16	C5	SI*	M	.46	C2	C7	SI*
F-3	.37	C2*	M	C4	.22	C2*	C7	SI	.51	C4	C2*	SI
F-4	.12	C5*	SP	R	.41	C7	SP	C5*	.72	C7	R	C5*
F-5	.52	M*	C5	C3	.53	C5	R	M*	.68	M*	R	C1
F-6	.23	F0*	SI	C1*	.18	C1*	SI	F0*	.46	F0*	C1*	M
F-7	.10	C1*	M*	C7	.14	C3	C1*	M*	.17	M*	C7	C1*
F-8	.17	F2*	C3	R	.18	F7	C2	F2*	.22	F2*	C2	R
F-9	.29	C2	SP	F2	.14	F1	C2	SP	.33	F2	M	F1
F-10	.47	F8	C1*	C2	.46	SI	C1*	C2	.51	SI	C1*	C4
C-1	.18	C6	R*	M*	.18	C6	R*	M*	.61	R*	C8	M*
C-2	.87	F4*	R*	C7*	.84	F4*	R*	C7*	.93	F4*	R*	C7*
C-3	.15	F5	G*	C8	.31	F7	G*	F2	.31	F5	G*	C8
C-4	.47	F3	C7*	F4	.51	M	F4	C7*	.97	C7*	F3	M
C-5	.42	F7*	C1	R	.31	F4	R	F7*	.21	F7*	C3	F4
C-6	.23	F3	SI	F8	.13	F8	SI	F4	.38	F6	C3	F3
C-7	.21	C4*	SP	F1*	.52	F1	C4*	F1*	.80	F8	C4*	F-1*
C-8	.16	C3	M	F1	.30	F1	SI	M	.23	C3	SI	C4
C-9	.16	F3	F7	M	.36	F7	C7	M	.35	F3	M	C7
C-10	.52	F5*	SI*	F6	.38	SI*	F5*	C4	.45	F6	SI*	F5*
MNG.	.81	F1	R*	C1	.87	R*	F2	C7	.87	C7	R*	C1
GEN.	.41	F7	C1*	F2	.97	M	F7	C1*	.99	M	F2	C1*
S.P.	.58	F1	C1	R	.94	M	F2	C8	.88	M	F2	C1
RESP.	.80	C7	G*	F1	.85	G*	F1	C7	.95	G*	C2	F3
S.I.	.62	C7	G*	F1	.81	G*	C1	C7*	.65	G*	C7*	C4

Random (Non-recurring) Independent Variable.

Recurred as predictor of dependent variable in 2 out of 3 samples.

* Recurred as predictor of dependent variable in all 3 samples.

Table 9: Levels of Significance for the Observed F-Values in 150 Multilinear Backward Elimination Regression Analyses

Dep. Var.	ELEMENTARY SCHOOL DATA						SECONDARY SCHOOL DATA					
	Year 01		Year 02		Year 03		Year 01		Year 02		Year 03	
	F-Value	p <	F-Value	p <	F-Value	p <	F-Value	p <	F-Value	p <	F-Value	p <
F-1	6.5	.001	0.7+	.50**	9.8	.001	3.3	.025	1.4	.75**	19.4	.001
F-2	19.0	.001	13.4	.001	16.4	.001	2.0	.75**	5.5	.005	17.1	.001
F-3	7.9	.001	2.3	.10**	10.3	.001	9.0	.001	8.2	.001	7.8	.001
F-4	21.4	.001	14.6	.001	10.6	.001	4.2	.01	12.9	.001	10.9	.001
F-5	103.4+	.001	71.9	.001	10.7	.001	25.4	.001	33.0	.001	8.9	.001
F-6	6.8	.001	9.6	.001	20.5	.001	3.4	.025	2.4	.10**	3.6	.025
F-7	3.8	.025	9.0	.001	3.3	.05	2.0	.75**	2.2	.10**	0.8	.50**
F-8	3.5	.025	15.9	.001	2.0	.75**	3.0	.05	3.0	.05	1.7	.75**
F-9	12.3	.025	15.5	.001	4.5	.01	4.6	.01	4.6	.01	4.7	.01
F-10	107.7+	.001	16.1	.001	17.9	.001	7.2	.001	11.9	.001	4.3	.01
C-1	3.4	.025	2.4	.10**	3.3	.05	6.8	.001	1.5	.75**	5.1	.005
C-2	373.7	.001	221.1	.001	136.9	.001	129.8	.001	157.0	.001	82.4	.001
C-3	4.2	.01	87.9	.001	2.0	.75**	3.3	.025	3.9	.025	2.6	.10**
C-4	42.4	.001	56.7	.001	32.1	.001	27.4	.001	20.1	.001	92.5	.001
C-5	87.9	.001	17.3	.001	1.1	.50**	11.0	.001	3.4	.025	1.8	.50**
C-6	6.2	.001	4.6+	.025	24.4	.001	3.7	.025	4.3	.01	3.8	.025
C-7	27.5	.001	68.0	.001	42.9	.001	4.1	.01	20.2	.001	80.3	.001
C-8	6.6	.001	100.6	.001	1.8	.75**	5.6	.005	8.2	.001	1.3	.75**
C-9	7.2	.001	12.1	.001	19.5	.001	6.2	.001	10.6	.001	1.3	.50**
C-10	9.3	.001	12.5	.001	15.2	.001	19.8	.001	8.3	.001	7.9	.001
M	67.9	.001	204.9	.001	156.1	.001	83.1	.001	128.9	.001	32.1	.001
G	106.4	.001	537.5	.001	464.9	.001	20.2	.001	608.1	.001	346.8	.001
SP	95.6	.001	873.9	.001	299.5	.001	36.3	.001	464.0	.001	71.2	.001
R	185.9	.001	235.5	.001	189.5	.001	82.4	.001	109.9	.001	134.1	.001
SI	105.2	.001	132.5	.001	46.0	.001	51.9	.001	47.3	.001	7.8	.001

+For 2-Variable equation.

**Not an acceptable level of significance.

Table 10: Stability of Predictability of Study Variables from Sample to Sample within School Levels.

			Elementary Level	Secondary Level
STABLE	With Consistently Ample+R^2		F-5 C-2 C-4 C-7 C-10 M G SP R SI	F-5 F-10 C-2 C-10 M R SI
STABLE	With Consistently Low R^2		F-2	F-7* F-8*
Not Characterized as to Stability		Ample R^2	F-4 F-10	F-3 C-4 C-5* C-9*
Not Characterized as to Stability		Low R^2	F-6 F-8* F-9 C-1*	F-6* F-9 C-8* G
UNSTABLE	With Inconsistently Ample R^2		C-9	F-4 G C-7
UNSTABLE	With Inconsistently Low R^2		F-1* F-3* F-7 C-3* C-5* C-6 C-8*	F-1* F-2* C-1* C-3* C-6

*Indicates that a least one of the 3 regressions within the school level for the variable did not reach $p < .05$.

+Ample R^2 = In at least 2 of the three samples, the R^2 was high enough to account for a meaningful proportion of the variance.

Perhaps the most conclusive findings are those concerned with the recurring predictors. As indicated in Tables 7 and 8, some study variables consistently predicted the same dependent variable from sample to sample within a school level. These predictors are referred to as Recurring Variables and are specifically identified in Table 11.

The anticipated differences between Secondary and Elementary classroom functioning show clearly in Table 11. For only two dependent variables (F-10 and C-5) are the Recurring Variables exactly the same at both levels. In a further 9 cases (dependent variables F-7, C-2, C-4, C-9, C-10, M, R, and SI), at least one common Recurring Variable was a predictor for all three samples at both school levels. Of these 9 cases, only two (F-7 and C-2) share two Recurring Variables as a predictor for all three samples at both school levels.

It is obvious from scanning Table 11 that some variables featured more frequently as predictors of the other study variables. The relative frequency of each of the study variables as a predictor is summarized in Table 12.

Of the 4 most frequently occurring predictors, two (M and R) are teacher interpersonal skill variables, one is a student interpersonal process variable (SI), and one is a student behavior variable (C-7). These two student variables -- one dealing with the level of the student's involvement in his learning activities and the other reflecting his production of thinking above the "use of facts" level on Bloom's Taxonomy of Cognitive Objectives[6] -- are the only two student variables to feature in the top half of the list. Of the first 12 most frequently occurring variables, there are 3 teacher interpersonal skill variables (M, R, G), two student variables (SI, C-7), 3 teacher affective response variables (F-2, F-7, and F-1), 3 variables of teacher elicitation of student participation (C-2, F-4, and C-4), and one teacher production variable (C-1).

All but two (C-1 and F-7) of the teacher variables which ranked among the top 12 can be considered to be in the class of interpersonal interaction which was characterized by Flanders[7] as "Indirect Behavior." Two of the four most frequently recurring

---

[6] Bloom, B. S. (Ed.); Englehart, M. D.; Furst, E. J.; Hill, W. H.; and Krathwohl, D. R. A Taxonomy of Educational Objectives: Handbook I, The Cognitive Domain. New York: Longmans, Green, 1956.

[7] Ned A. Flanders, op. cit.

Table 11: Recurring* Predictive Variables

Dependent Variable	ELEMENTARY TEACHERS: Variables Recurring as Predictive of Dependent Variable in Equations for 2 Samples	ELEMENTARY TEACHERS: Variables Recurring as Predictive of Dependent Variable in Equations for 3 Samples	SECONDARY TEACHERS: Variables Recurring as Predictive of Dependent Variable in Equations for 2 Samples	SECONDARY TEACHERS: Variables Recurring as Predictive of Dependent Variable in Equations for 3 Samples
F-1	M, C-7	F-9	M, SI	C-7
F-2	SI	C-2, M	C-7, C-5	SI
F-3		C-7, SI	C-4, SI	C-2
F-4	R, C-5, C-7	C-6	SP, R, C-7	C-5
F-5	R, C-3	C-5	C-5, R	M
F-6	M, C-1, C-2, SI		SI	F-10, C-1
F-7		C-1, M, C-2		C-1, M
F-8	C-2	F-7, R	R, C-2	F-2
F-9	C-2	M	C-2, SP, F-2, F-1	
F-10	SI, C-2	C-1	C-2, SI	C-1
C-1	M, R, C-6	C-8	C-6	R, M
C-2	M	F-4, C-7		F4, R, C7
C-3	F-2	F-5, C-8	F-5, C-8	G
C-4		C-7, F-4, M	F-3, F-4, M	C-7
C-5	F-4, F-7	R	R, F-4	F-7
C-6	F-4, F-8, SI		F-3, SI, F-8	
C-7	F-8, SP	C-4		C-4, F-1
C-8	M, SI, C-3, C-4		C-3, M, F-1, SI	
C-9	F-1	F-7, M	F-3, F-7, C-7	M
C-10	C-4, F-5	SI	F-6	F-5, SI
M		R, F-2	C-1, C-7	R
G	F-7, M	F-2	F-7, F-2, M	C-1
S.P.	F-2, C-4, M, C-1		M, C-1, F-2	
R	C-7, F-3	G	F-1, C-7	G
S.I.	F-1, C-7	G		G, C-7

*Recurring from sample to sample as predictor for same dependent variable.

Table 12: Summary of Predictive Appearances of Recurring Variables

Predictive Variables	No. of Appearances		
	Total	Elementary Data	Secondary Data
M : Meaning	53	29	24
C-7 : Student Thinks	39	17	22
SI : Student Involvement	34	16	18
R : Respect	32	15	17
C-1 : Teacher Recalls Facts	25	10	15
C-2 : Teacher Asks For Facts	23	14	9
F-2 : Teacher Praise	19	10	9
F-4 : Teacher Asks Questions	17	10	7
F-7 : Teacher Criticizes	17	10	7
G : Genuineness	15	6	9
C-4 : Teacher Ask For Thinking	14	9	5
F-1 : Teacher Accepts Feelings	13	4	9
C-5 : Student Recalls Facts	12	5	7
F-5 : Teacher Lectures	10	5	5
F-3 : Teacher Accepts Ideas	8	2	6
C-8 : Student Asks For Thinking	8	6	2
C-3 : Teacher Thinks	7	5	2
C-6 : Student Asks for Facts	7	5	2
F-8 : Student Responds	6	4	2
SP : Success Promotion	6	2	4
F-9 : Student Initiates	3	3	*
F-10: Silence or Chaos	3	*	3
F-6 : Teacher Gives Directions	2	*	2
C-9 : Non-Cognitive Behavior	*	*	*
C-10: Silence and Chaos	*	*	*

*Variable occurred only at random in this data; i.e., it did not recurr from sample to sample within a level as predictor for the same dependent variable.

predictive variables are among those facilitative conditions (M, R) that Rogers[8] postulated as being positively related with effective learning environments. A third variable (G) which had been postulated by Rogers ranked in the top half of the list of Recurring Variables.

In general, the order of the variables in terms of their frequency of appearance as recurring predictors is similar for the Elementary and the Secondary data sets, although there are some inconsistencies between the sets. This is especially interesting in view of the fact that reference to Table 11 demonstrates that the study variables predicted by these Recurring Variables are not necessarily the same from Elementary to Secondary data sets.

From Construction of Response Surfaces:

The first step -- regression analysis -- was successful in (1) demonstrating that there were replicable, predictable, and significant relationships among these variables of classroom functioning, and (2) identifying the most frequently recurrent predictors for each of the study variables. The next step was to examine the directionality and the dynamic inter-relationships of the study variables through constructing response surfaces.

Data was fed into regression equations in which there were only two variables remaining and into the equations in which there were three variables remaining; thus generating plot points with which to construct 2-variable and 3-variable response surfaces. The data of choice fed into the equations consisted of values representing (1) two standard deviations below the mean or 0.0 (whichever was the largest), (2) two standard deviations above the mean, and (3) the point halfway between the first two values. If this data resulted in a surface that extended into unreal dimensions, a second set of data (based on one standard deviation), was used to generate the plot points.

Extending into an unreal dimension was defined as extension beyond the possible limit of observed values; i.e., since only 240 3-second intervals are observed in each tape, any Flanders or Cognitive surface extending to a point with a value larger than 240 was beyond the possible limits of observed values. Similarly, any negative value is not a possible observation for these variables. The possible observed limits of the Process Scales are 1.0 and 5.0.

---

[8] Carl R. Rogers. "The Interpersonal Relationship in the Facilitation of Learning." In Robert R. Leeper (ed.), Humanizing Education: The Person in the Process. (Washington, D.C.: Association for Supervision and Curriculum Development, NEA), 1967; pp. 6-7.

If generation of plot points using the set of data based on one standard deviation still resulted in extension into unreal dimensions, the surface was accepted. The unreal values were indicated with broken lines.

Representative response surfaces are displayed in Appendixes A and B. The surfaces to be displayed were selected from among the 300 surfaces generated by the 150 2-variable and the 150 3-variable equations which had been derived from the three samples at each of the two school levels. Thus, three 2-variable and three 3-variable surfaces had been generated for each of the study variables at each school level. One 2-variable response surface for each study variable at each school level is displayed in Appendix A. Selected 3-variables surfaces are displayed for (1) each of the student behavior variables and (2) for most of those teacher variables which were frequently recurring predictor variables. The 3-variable surfaces are presented in Appendix B.

The surfaces displayed for each variable were selected from among the three samples on these bases:

1. The Year 03 surfaces were eliminated from consideration because of small sample size and reduced levels of significance.

2. Because of the large sample size, surfaces from Year 01 regressions were given 1st priority.

3. Year 02 surfaces were presented in lieu of Year 01 surfaces when they (a) explained significantly more variance and (b) included an additional Recurring Variable among the predictors of the surface.

When Year 02 surfaces are presented, they are labeled 02 in a parentheses following the designation of school level in the heading at the top of the figure.

The regression equation, multiple correlation squared, standard error of the estimate, and observed $\overline{F}$ for the regression are displayed for each surface. In the set of figures for the 3-variable surfaces, the value of the variable to hold constant for the figure is presented in the box under each figure in the set.

Each surface (or set of figures for 3-variable surfaces) is designed to be examined as a self-contained entity, but comparison across surfaces is possible if the following cautions are observed:

1. The scales are not standardized from variable to variable due to the widely varying frequencies of observed behaviors in the different variables.

2. In some cases, the direction of labeling the values for a predictor variable has been reversed in order to rotate a "high" point to the rear of the surface; thus enabling the entire surface to be visible.

In order to facilitate comparison of the differences between Elementary and Secondary dynamics, the surfaces for the same dependent variables are arranged face to face. The first parentheses following the name of the response surface at the top of each figure contains the designation "Elem." or "Sec." to indicate the appropriate school level for the surface.

Each surface presents its own exhibit of the dynamics of the inter-relationships, but two general observations may be made of the surfaces as a set. First, many of the variables are related in a curvilinear rather than linear fashion. All but 11 of the 150 2-variable regression equations contain at least one quadratic or cross-product term, while 146 of the 3-variable equations contain such a term. In 51 of the 86 response surfaces displayed in this report, the curvilinear relationship is strong enough to be clearly visible in the figures as presented.

Second, the surfaces emphasize the dynamic quality of the inter-relationships of the variables. In several cases, the directionality of the relation between the dependent variable and a predictor variable is completely reversed as the value of a second predictor variable changes. For example, see 2-variable surfaces F-2 (Sec.), F-6 (Elem.), C-1 (Elem.), and C-3 (Sec.). This characteristic is even more pronounced in some of the 3-variable surfaces, such as F-2 (Elem.), C-3 (Sec.), C-4 (Sec.), C-8 (Elem.), and SI (Sec.).

DISCUSSION

The first implication to be drawn from the study is related to the graphic demonstration in the response surfaces of strong curvilinear and dynamic relationships among the variables. The inability to detect significant and replicable relationships among instructional variables has long been a matter of concern

to educators[8]; however, until recently most of the research has used statistical methods predicted on linear models.[9] The implication to be drawn from the surfaces presented here may well be that educational researchers will continue to obtain inconsistent and/or insignificant results until at least quadratic models are built and tested.

Although no cause and effect relationship can be established through regression analysis, an implication for teacher training can be drawn from the data which identifies specific Recurring Variables (Table 11) and demonstrates the frequency with which some of these Recurring Variables appear as predictors for other study variables (Table 12). Since so many aspects of teacher and student behavior were demonstrated to co-vary with a relatively few predictor variables, it would seem that attempts to change overall classroom functioning could be more efficient if training efforts were focused on the more highly predictive variables.

Examination of the individual response surfaces also provides guidance for focusing training to change specific aspects of teacher or student behavior. For example, examination of the displayed 2-

---

[8] Morsh, J. E. and Wilder, E. W. "Identifying the Effective Instructor: A Review of Quantitative Studies, 1900-1952." (Research Bulletin No. AFPTRC-TR-54-44) USAF Personnel Training Research Center, San Antonio, Texas; 1954, p.4.

Medley, D. M. and Mitzell, H. E. "Measuring Classroom Behavior by Systematic Observation," In N. L. Gage (Ed.), Handbook of Research on Teaching, Chicago: Rand McNally & Company, 1963. pp. 247-328.

Gage, N. L. "Desirable Behaviors of Teachers." Urban Education, 1 (1965), 85-95.

[9] Flanders, N. A. "Teacher Effectiveness." In R. L. Ebel (Ed.) Encyclopedia of Educational Research, Fourth Edn. Toronto: MacMillan, 1969.

Getzels, J. W. and Jackson, P. W. "The Teacher's Personality and Characteristics." Handbook of Research on Teaching. (Edited by N. L. Gage). Chicago: Rand McNally & Co., 1963. Chapter 11, pp. 506-82.

Ryans, D. G. "Assessment of Teacher Behavior and Instrution." Review of Educational Research, 33, No. 4 (1963), 415-441.

variable surfaces for F-9 (See Appendix A) suggests that in order to increase the amount of Student Initiation at the elementary school level, training should focus on helping the teacher to understand the meaning-to-the-student of his classroom experiences and to communicate acceptance of the student's feelings. At the high school level, training to increase student initiation should focus on helping the teacher (1) to raise his levels of skill in promoting the student's achievement of individual goals and (2) reduce the amount of time he spends asking students to recall facts.

The National Consortium for Humanizing Education had hypothesized early in the study that a humane classroom was characterized by four types of behavior:

1. Frequent acceptance of student feelings,
2. High amounts of student participation,
3. High levels of student thinking beyond the use of facts, and
4. High degrees of student involvement.

Therefore, it was especially interesting to the Consortium investigators when variables reflecting 3 of the 4 hypothesized behaviors turned up among those study variables which were the more frequent predictors of other aspects of classroom functioning. (See discussion, p. 16.) The fourth hypothesized behavior (high amounts of student participation) was perhaps indirectly represented by the three variables of teacher elicitation for student participation (C-2, F-4, and C-4) which were also among the more frequently appearing Recurring Variables.

One anecdotal comment is perhaps appropriate for inclusion here. When these response surfaces have been shown to either university level educators or public school personnel, the response has unaminously been one of interest and amazement. Typical of the reaction is the Secondary Science teacher, who after looking at sevaral surfaces which included F-5 as either the dependent variable or a predictor, exclaimed "I'll never lecture again!" These kinds of comments have aroused some speculation as to the possibilities for adapting the procedure in a simplified form so teachers could be provided with response surfaces from their own individual data. It might prove to be a powerful tool for changing teaching behavior.

SUMMARY

In conclusion, the findings from this study are:

1. Replicable, predictable, and significant relationships were detected among variables of teacher and student classroom functioning.

2. These relationships were different at the secondary and elementary school levels.

3. Specific recurring predictors for each of the study variables were identified.

4. Some of the classroom functioning variables co-varied significantly and frequently with a large number of the other study variables, and these predictors were few enough in number to suggest that efficient programs for changing overall classroom functioning could be developed by focusing training efforts on these few highly predictive variables.

5. The individual response surfaces generated for each study variable provide specific suggestions for focusing training efforts aimed at changing selected aspects of teacher or student behavior.

6. Two of the 4 most frequently recurring predictors (and 3 of the top 10) were variables which had been postulated by Rogers as being positively related to effective learning environments.

7. Most of the frequently recurring predictors were related to the kinds of behavior classified by Flanders as "Indirect."

8. The kinds of behavior hypothesized by the National Consortium for Humanizing Education as characterizing a humane classroom were also the kinds of behavior which were frequently recurring predictors of the other study variables.

9. The curvilinear relationships detected were strong enough and constant enough to suggest that educational researchers need to emphasize the building and testing of at least quadratic models.

APPENDIX A

SELECTED TWO-VARIABLE RESPONSE SURFACES

NOTES:

1. The response surfaces are arranged so that the Elementary and the Secondary School surfaces for the same variable are face to face.

2. Scale Units:

   For Flanders (F-) and Cognitive (C-) variables, the scale unit is the number of 3-second intervals of behavior in that category which would occur in 12 minutes selected at random (in four 3-minute segments) from 1 hour of instruction.

   For Process Scales variables (M, G, SP, R, SI), the unit is the mean level (rating) of the skill which would be maintained by the teacher during 12 minutes selected at random (in four 3-minute segments) from 1 hour of instruction.

3. The scales are not standardized from variable to variable due to the widely varying frequencies of observed behaviors in the different variables.

4. In some cases, the direction of labeling the values for a predictor variable has been reversed in order to rotate a "high" point to the rear of the surface, thus enabling the entire surface to be visible.

5. Broken lines indicate that the surface has extended into an unreal dimension. (See explanation, p.19.)

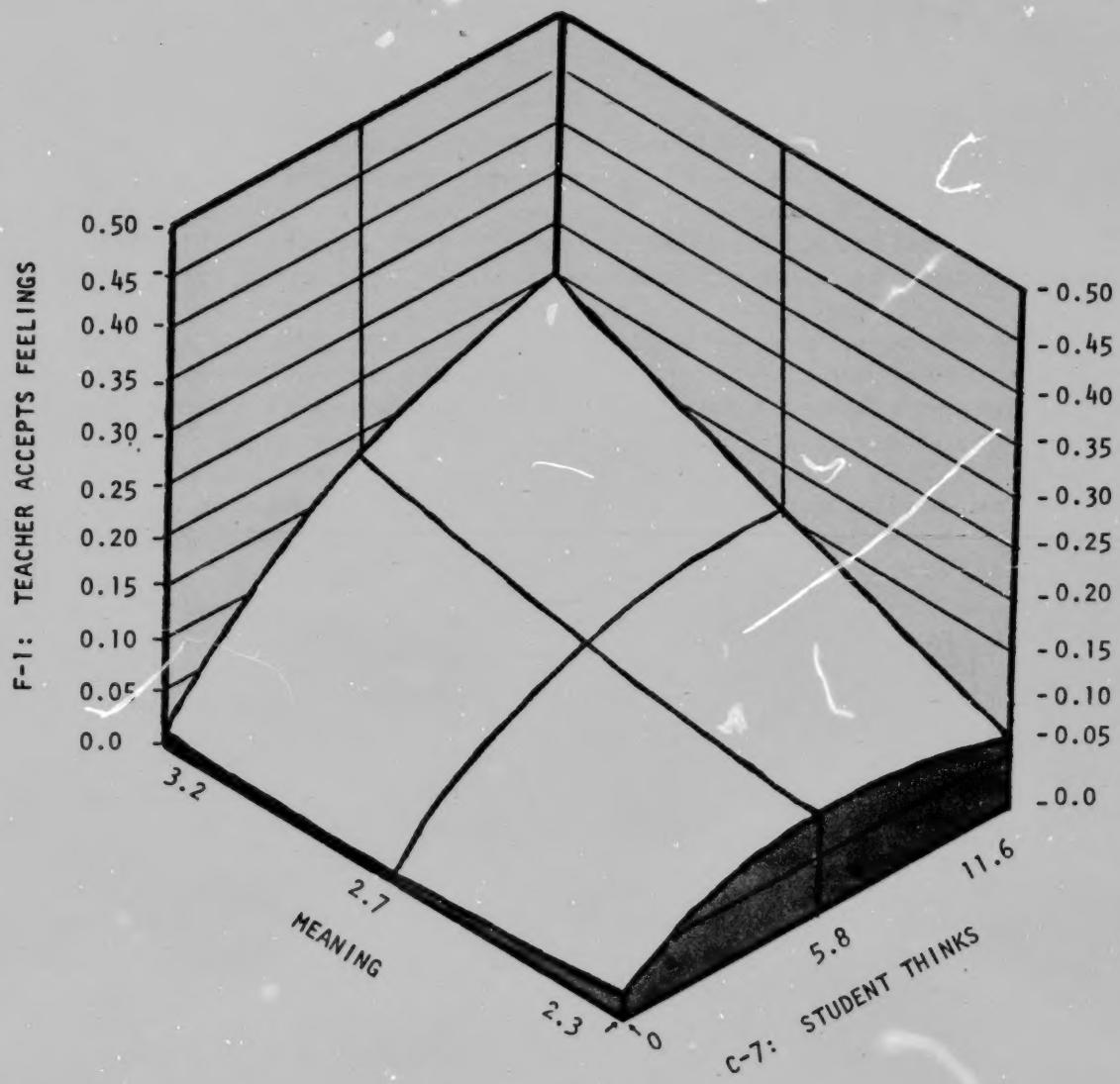
6. The number 02 in a parenthesis following the heading indicates the surface was generated from a regression equation derived from data in the Year 02 sample. All other surfaces were generated from Year 01 data.

7. Except where indicated otherwise, the regressions were significant at $p < .001$.

F-1: TEACHER ACCEPTS FEELINGS (ELEM.)

$F\text{-}1 = 0.02060 - 0.0209C7 - 0.0014C7C7 + 0.018C7M - 0.001MM$

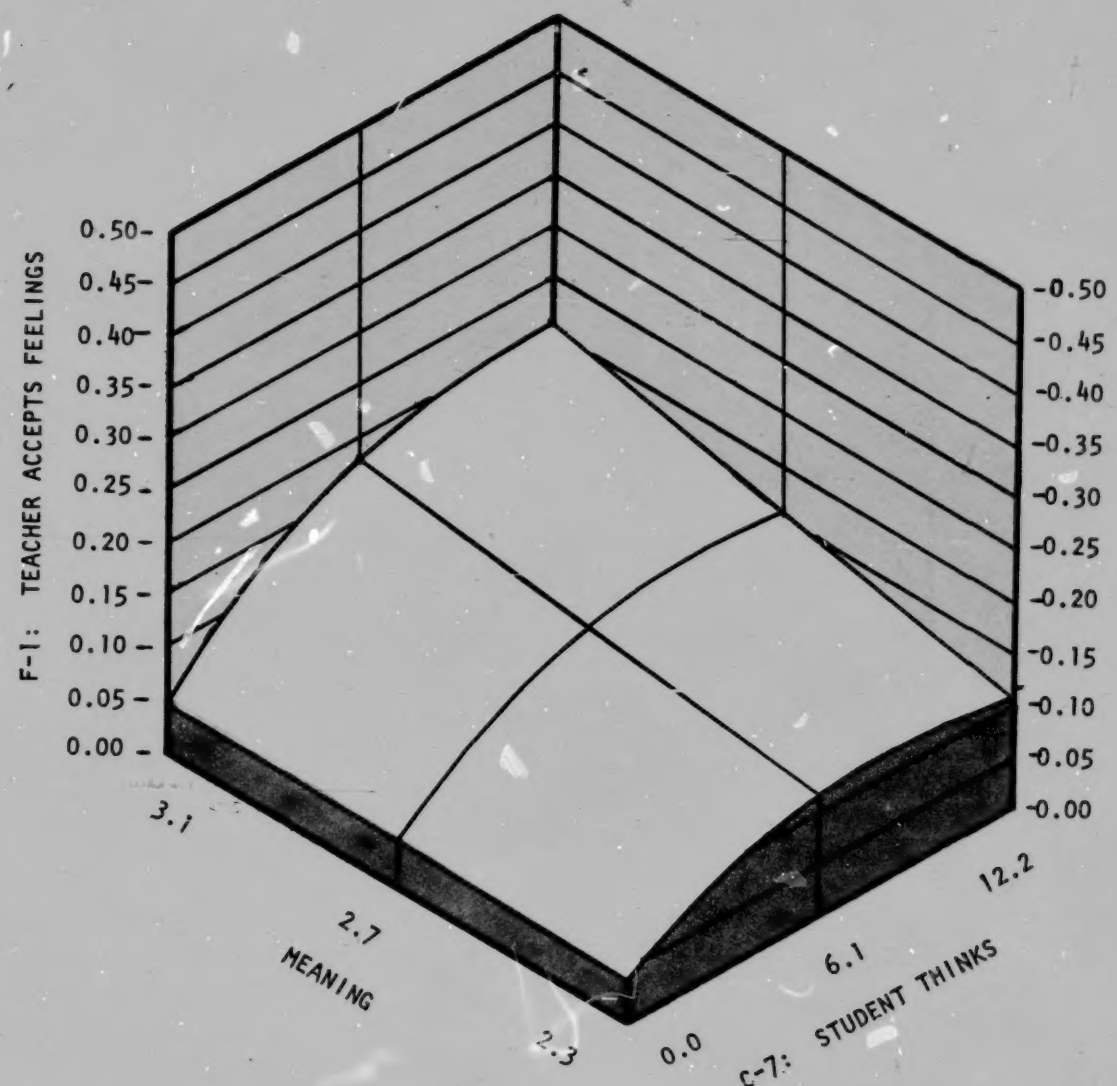
$R^2 = 0.166$ $s_E = 0.126$ $\underline{F} = 7.784$



F-1: TEACHER ACCEPTS FEELINGS (SEC.)

$F\text{-}1 = 0.03880 - 0.0014C7C7 + 0.010C7M$

$R^2 = 0.083$ $s_E = 0.170$ $\underline{F} = 4.304^*$

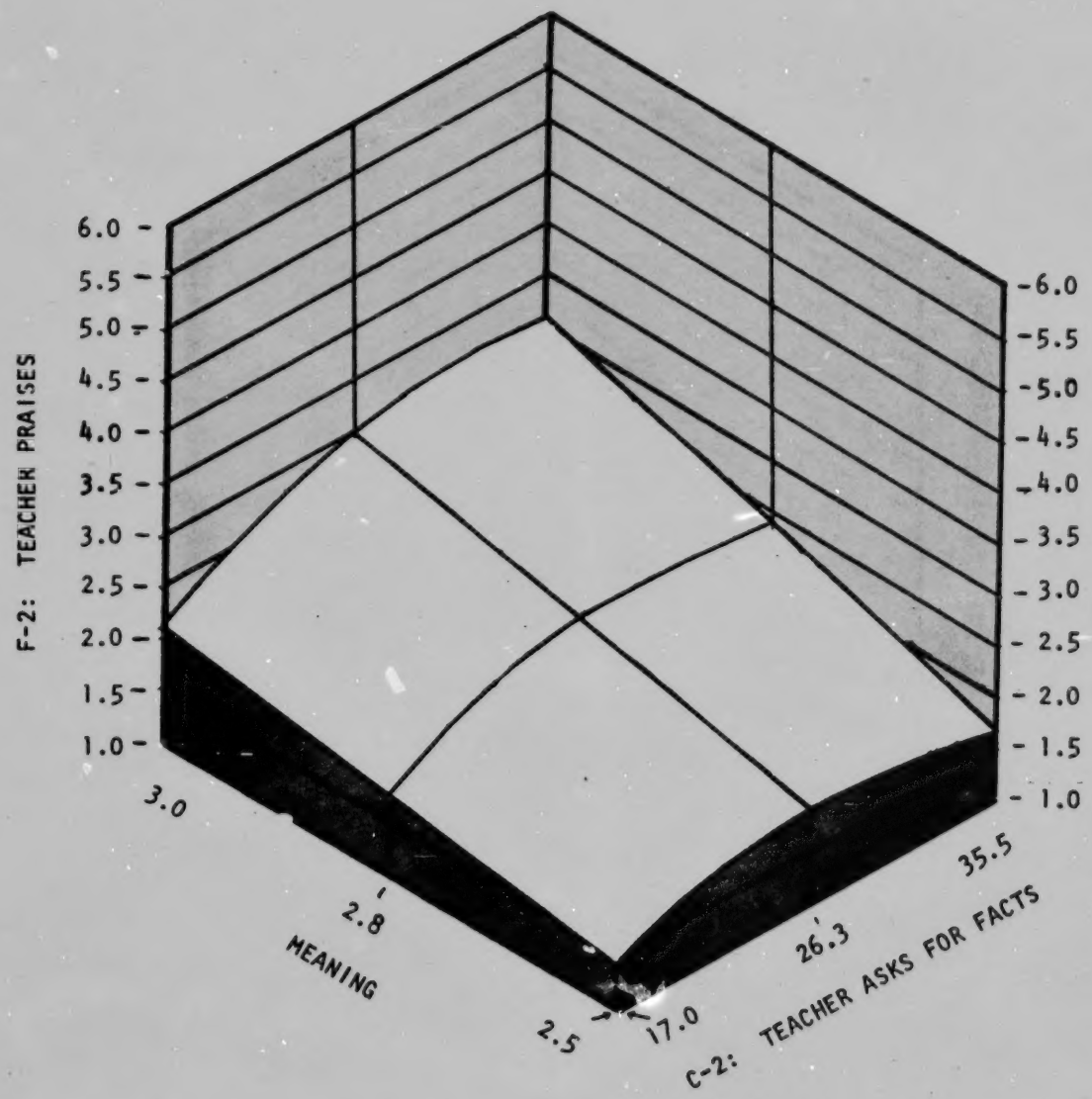


*p <.025

F-2: TEACHER PRAISES (ELEM.)

$F\text{-}2 = -1.4547 - 0.0044C2C2 + 0.9600C2M$

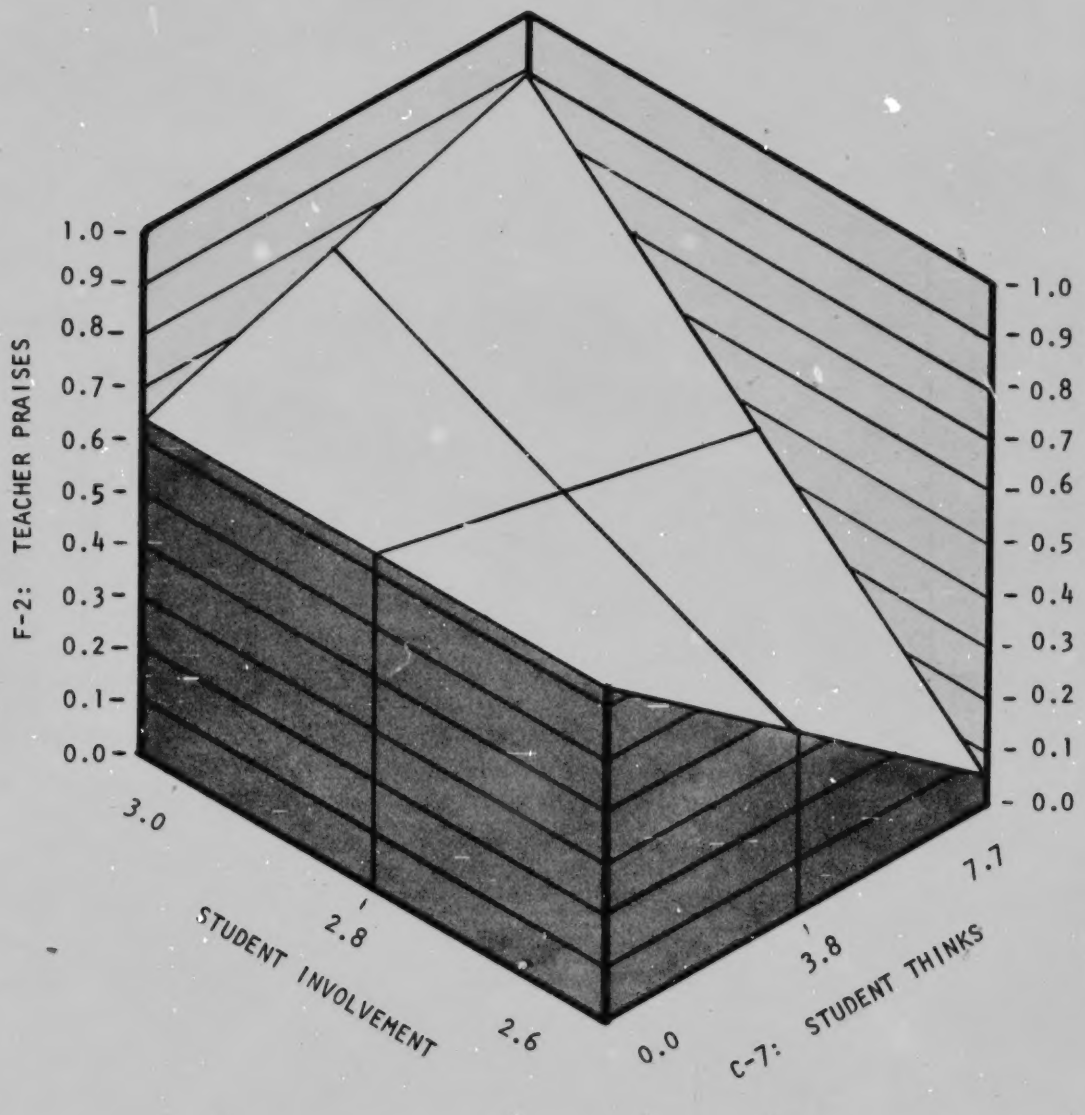
$R^2 = 0.252$ $s_E = 1.511$ $\underline{F} = 26.844$



F-2: TEACHER PRAISES (SEC.)

$F\text{-}2 = 0.63748 - 0.7281C7 + 0.252C7SI$

$R^2 = 0.055$ $\quad s_E = 0.758$ $\quad \underline{F} = 2.795^*$

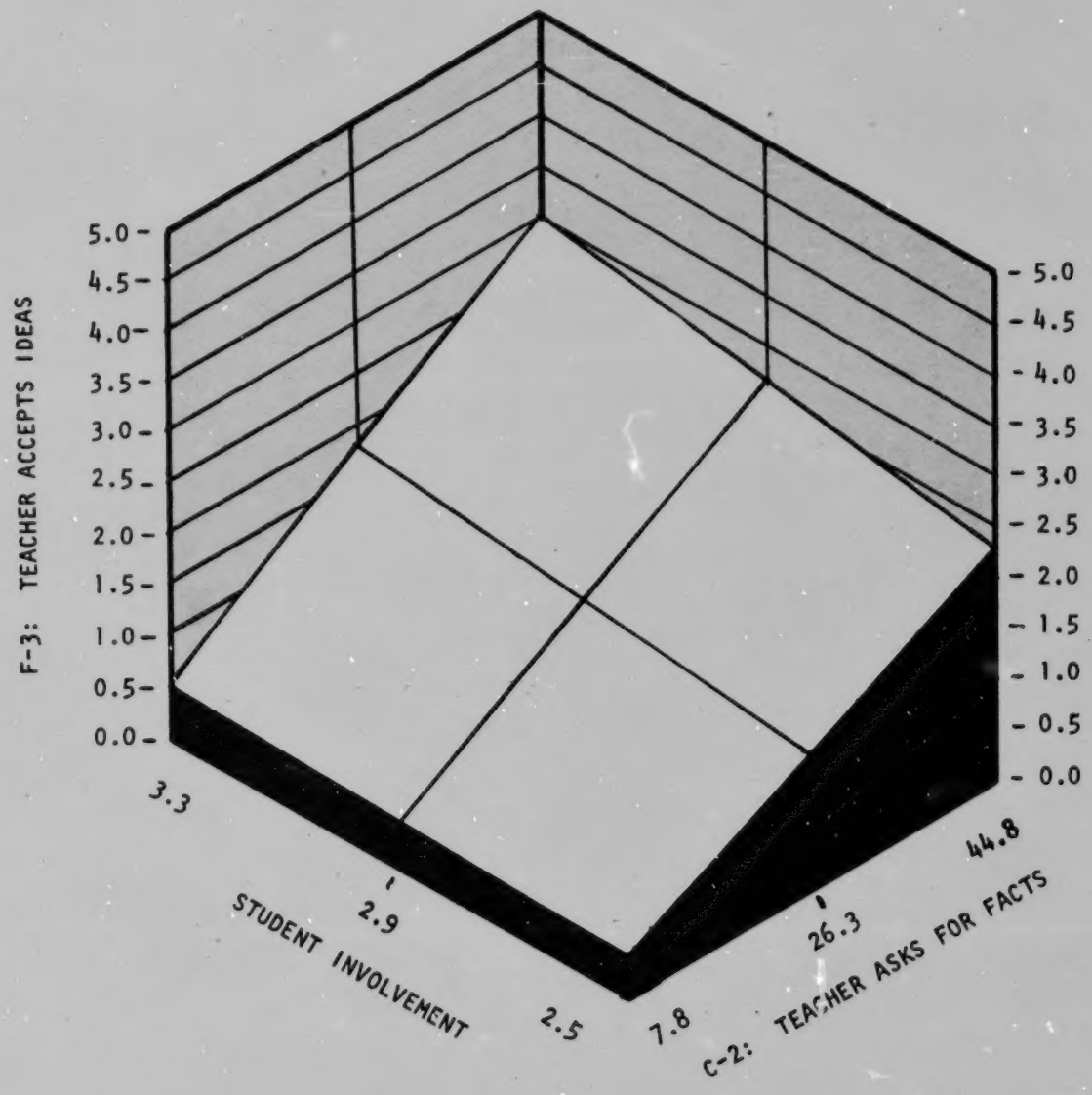


*p < .10

F-3 TEACHER ACCEPTS IDEAS (ELEM.)

$F\text{-}3 = -0.04657 + 0.0210C2SI$

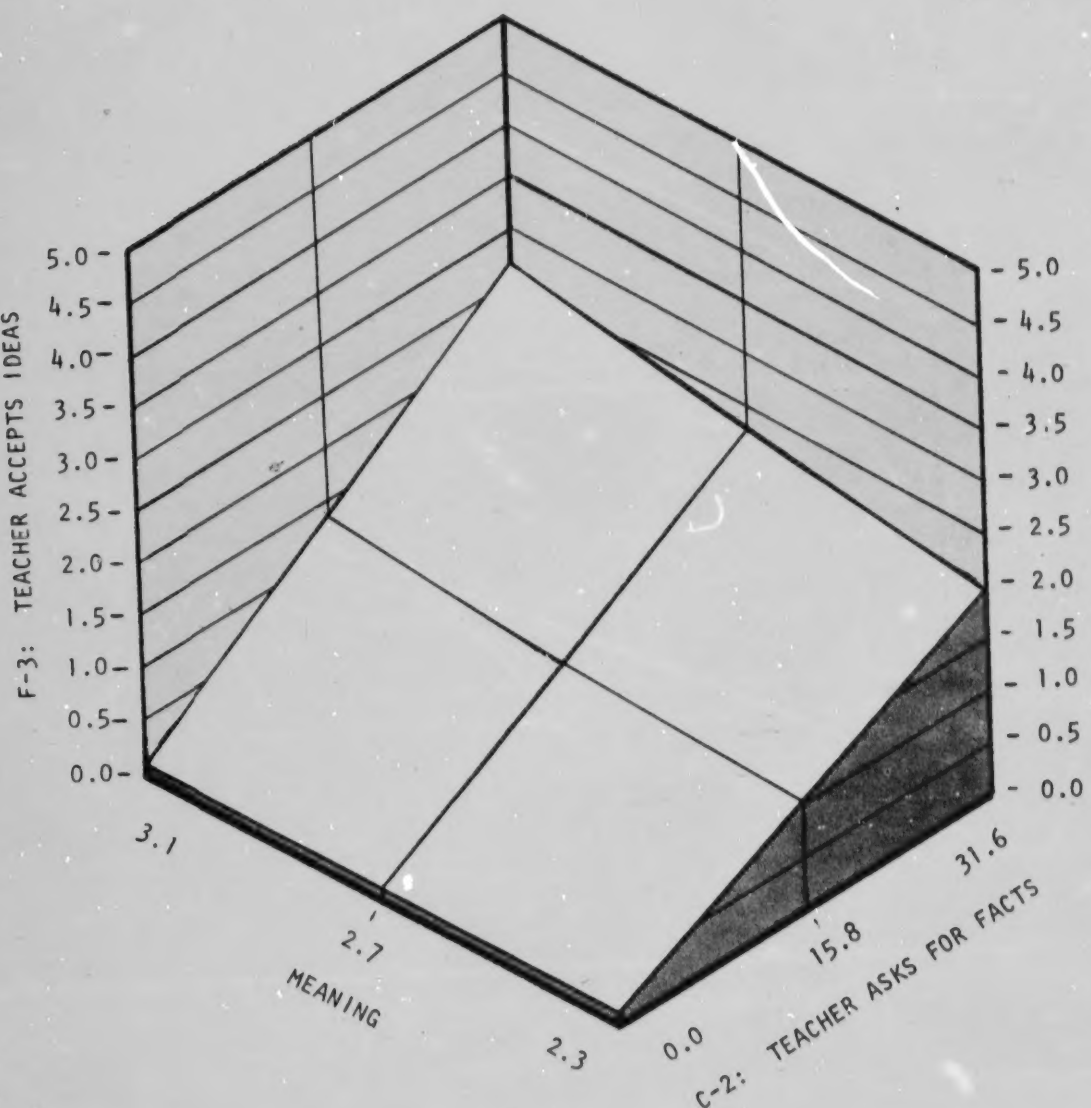
$R^2 = 0.215$ $S_E = 1.144$ $\underline{F} = 43.863$



F-3: TEACHER ACCEPTS IDEAS (SEC.)

$F\text{-}3 = 0.07370 + 0.026C2M$

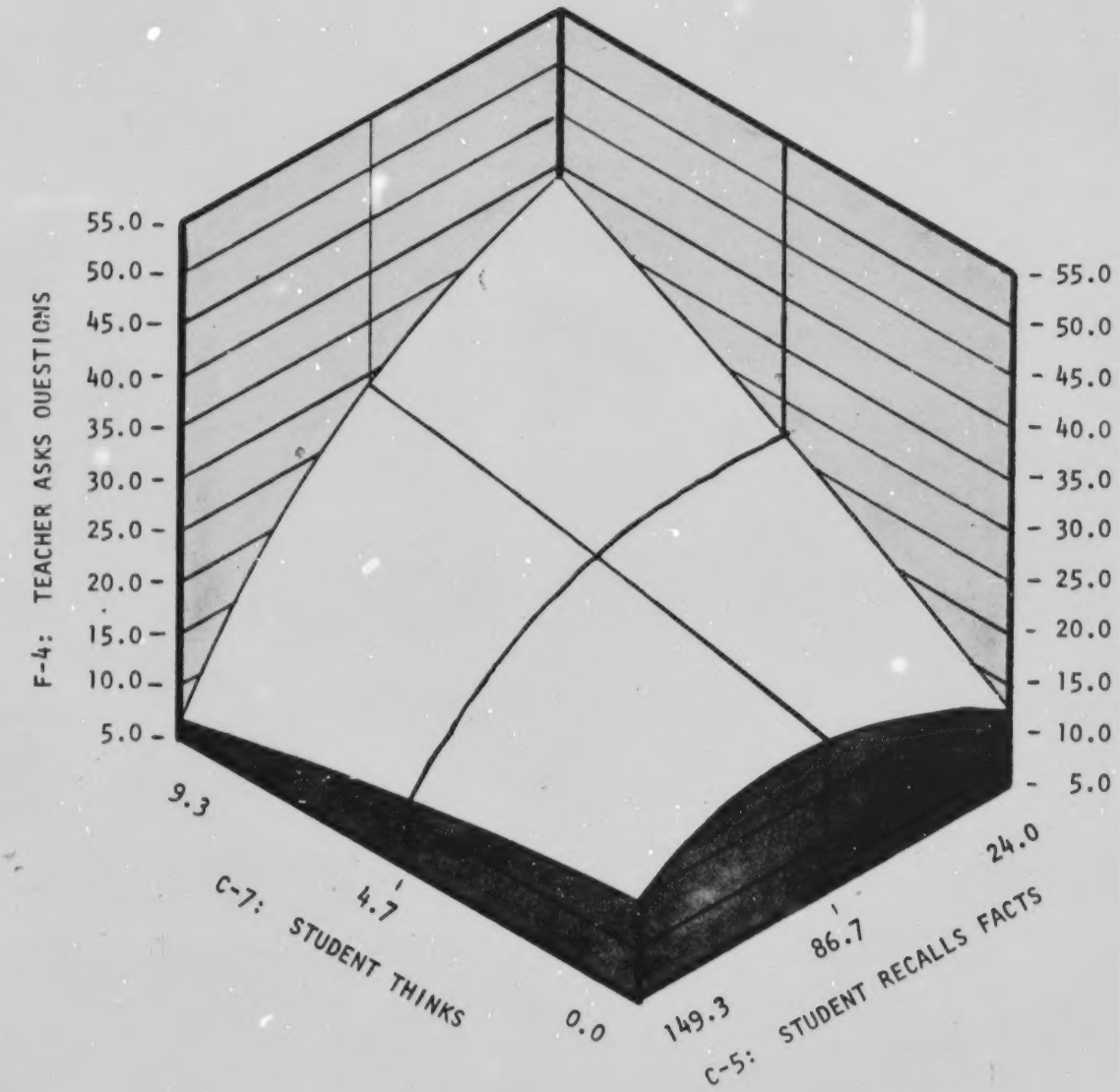
$R^2 = 0.246$ $\quad s_E = 1.08$ $\quad \underline{F} = 31.344$



F-4: TEACHER ASKS QUESTIONS (ELEM.) (02)

$F\text{-}4 = 6.97859 + 0.2881C5 + 3.9366C7 - 0.0016C5C5 - 0.0283C5C7 - 0.0554C7$

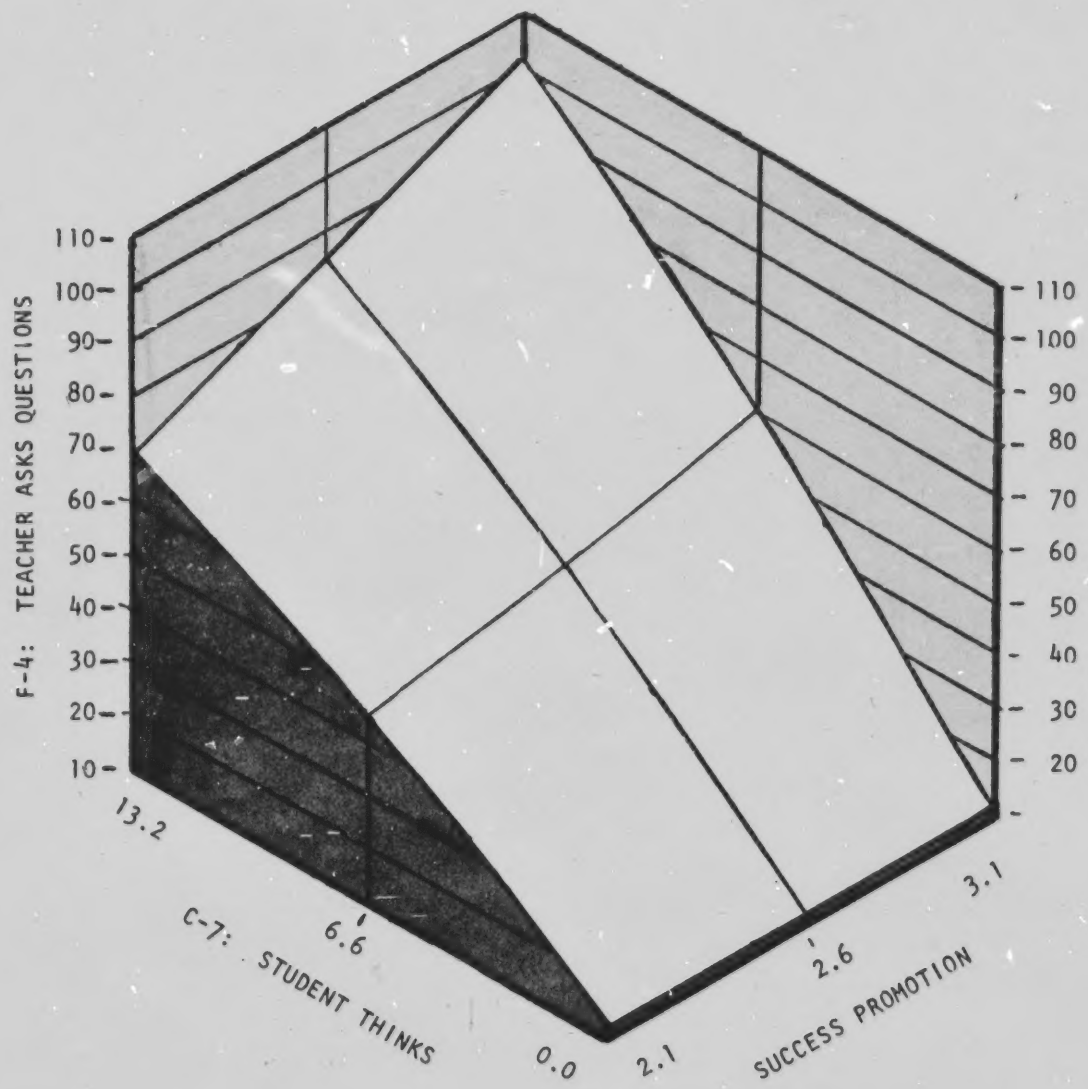
$R^2 = 0.412$ $s_E = 6.508$ $\underline{F} = 17.664$



F-4: TEACHER ASKS QUESTIONS (SEC.) (02)

F-4 = 10.667 + 2.482C7SP

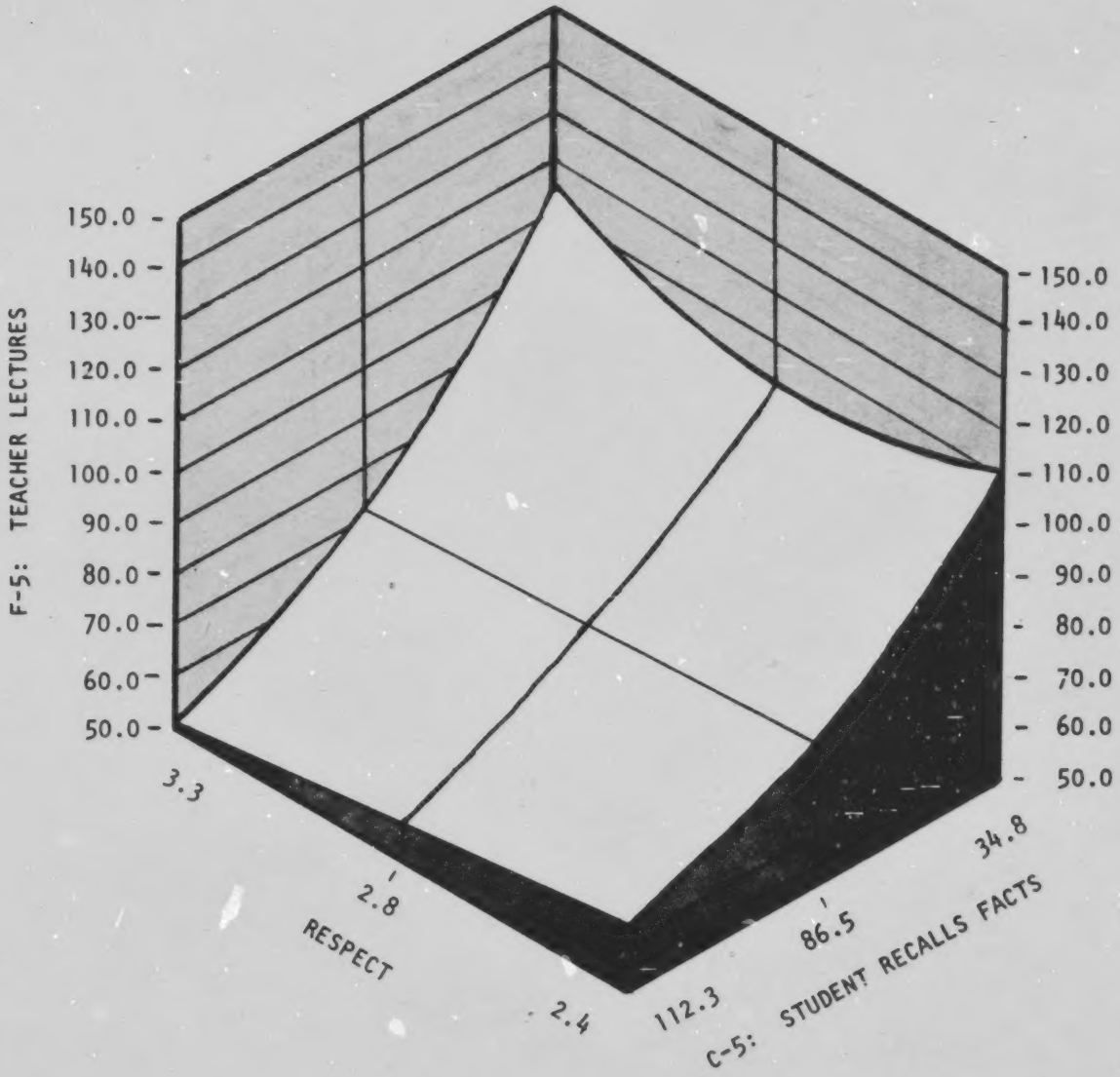
R^2 = 0.183 s_E = 7.263 $\underline{F}$ = 12.093



F-5: TEACHER LECTURES (ELEM.)

F-5 = 118.04724 - 0.2610C5R + 2.6100RR

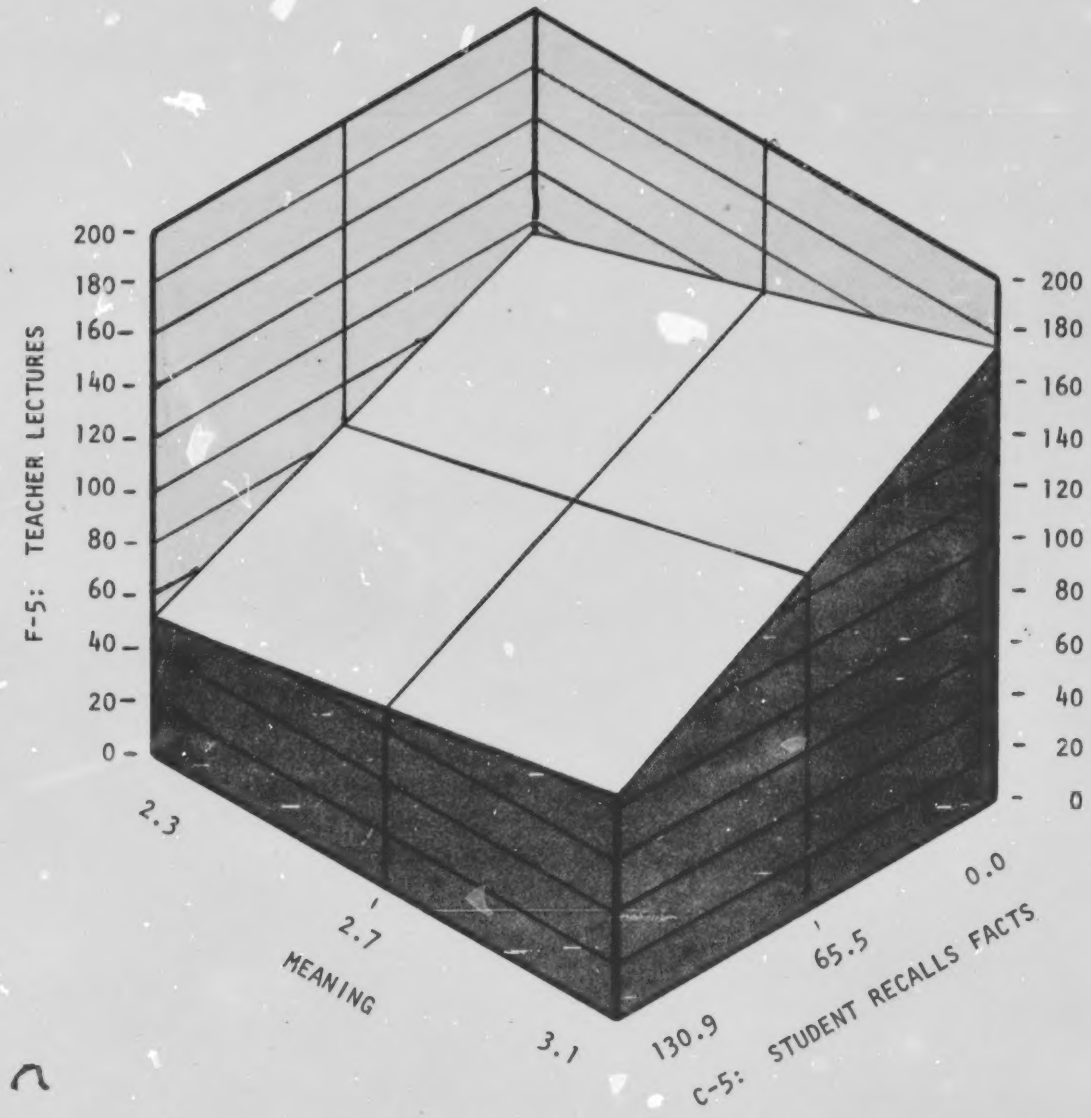
R^2 = 0.565 s_E = 16.238 $\underline{F}$ = 103.440



F-5: TEACHER LECTURES (SEC.)

$F\text{-}5 = -32.08981 + 65.847M - 0.220C5M$

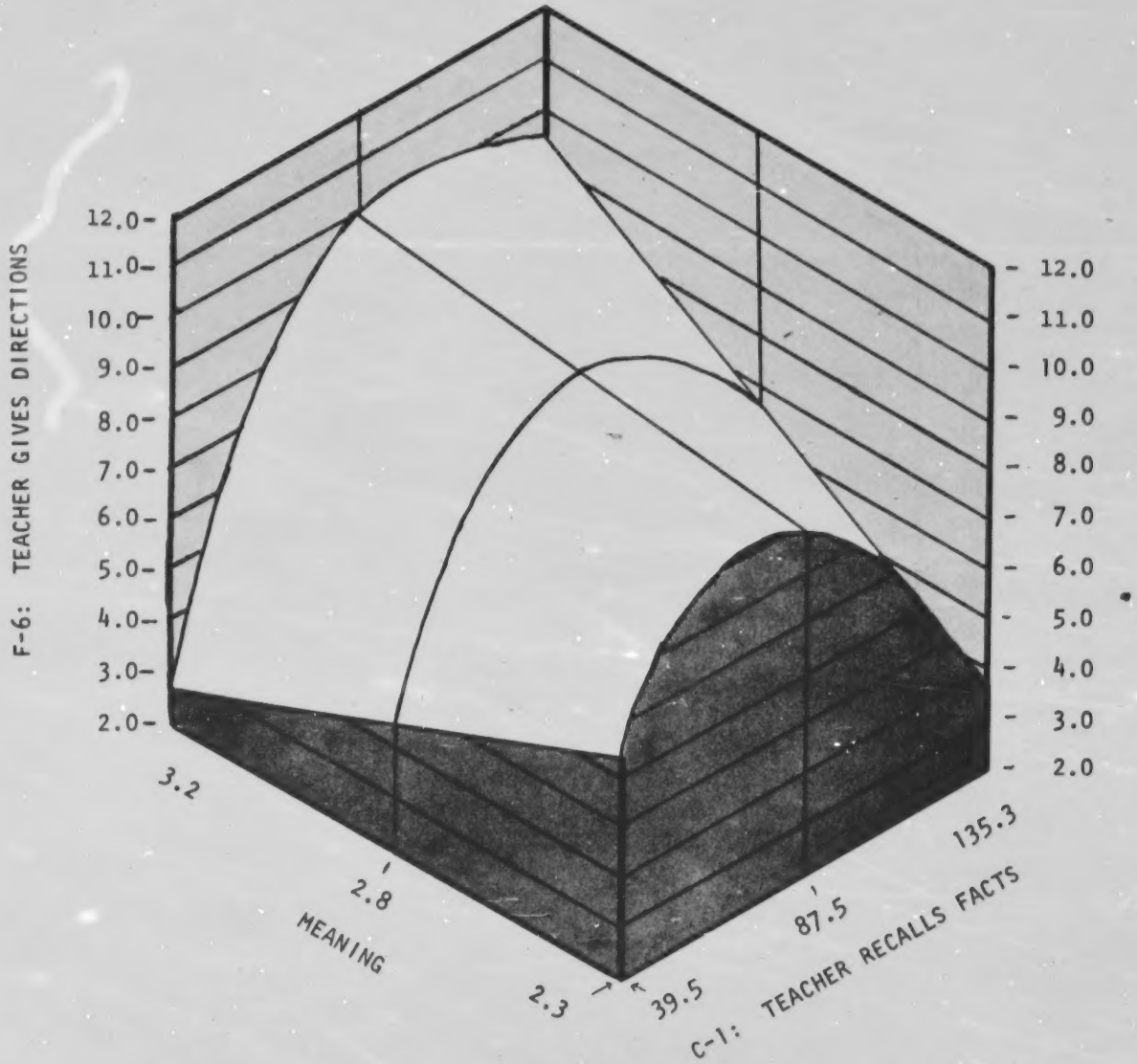
$R^2 = 0.431$ $s_E = 24.909$ $F = 36.001$



F-6: TEACHER GIVES DIRECTIONS (ELEM.)

$F\text{-}6 = 19.14824 - 8.951M - 0.0017C1C1 + 0.1160C1M$

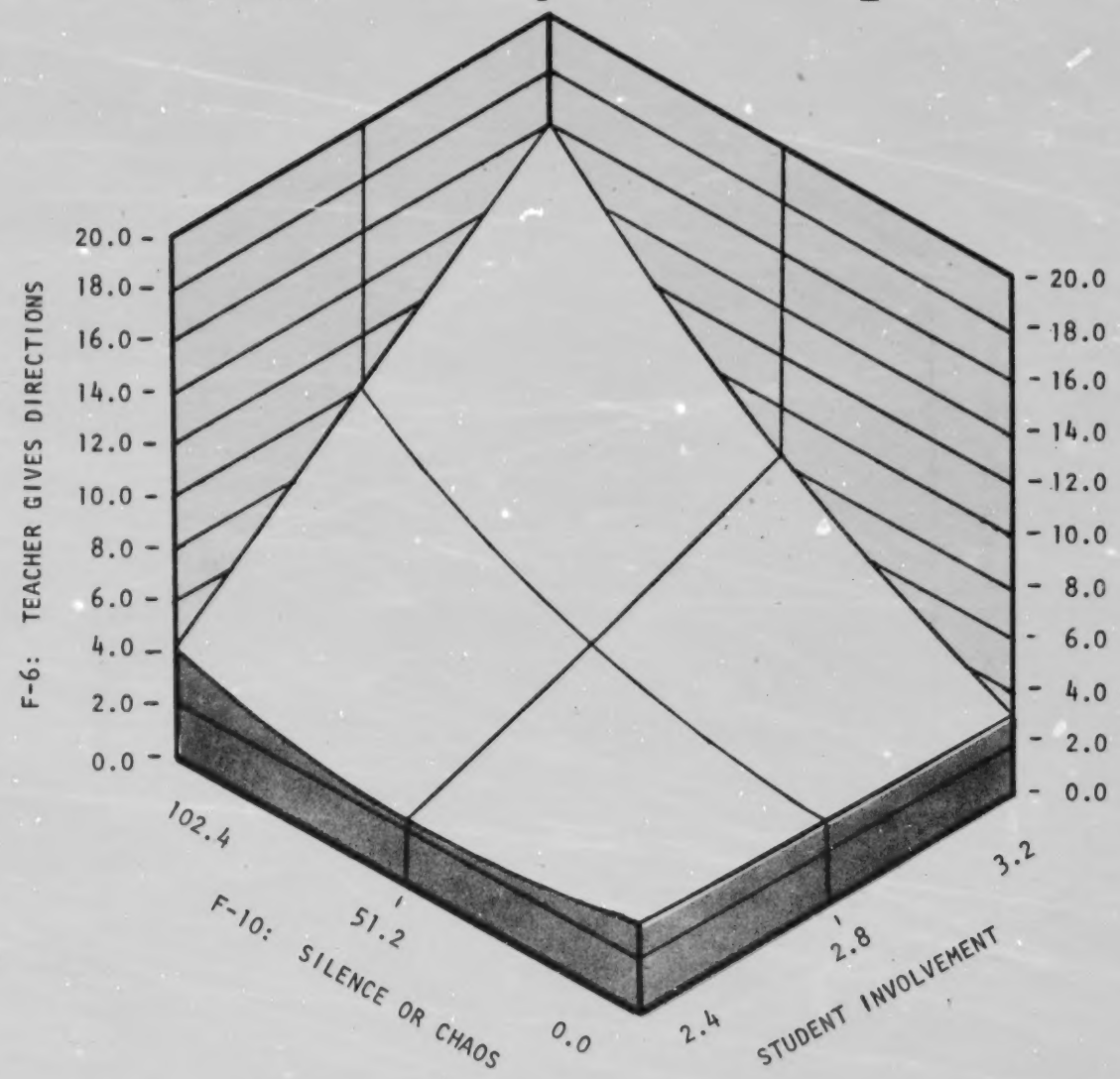
$R^2 = 0.129$ $S_E = 4.262$ $\underline{F} = 7.866$



F-6: TEACHER GIVES DIRECTIONS (SEC.)

$$F\text{-}6 = 60.37471 - 0.3295FO - 42.152SI + 0.137FOSI + 0.766SISI$$

$R^2 = 0.207$ $S_E = 3.641$ $\underline{F} = 6.085^*$

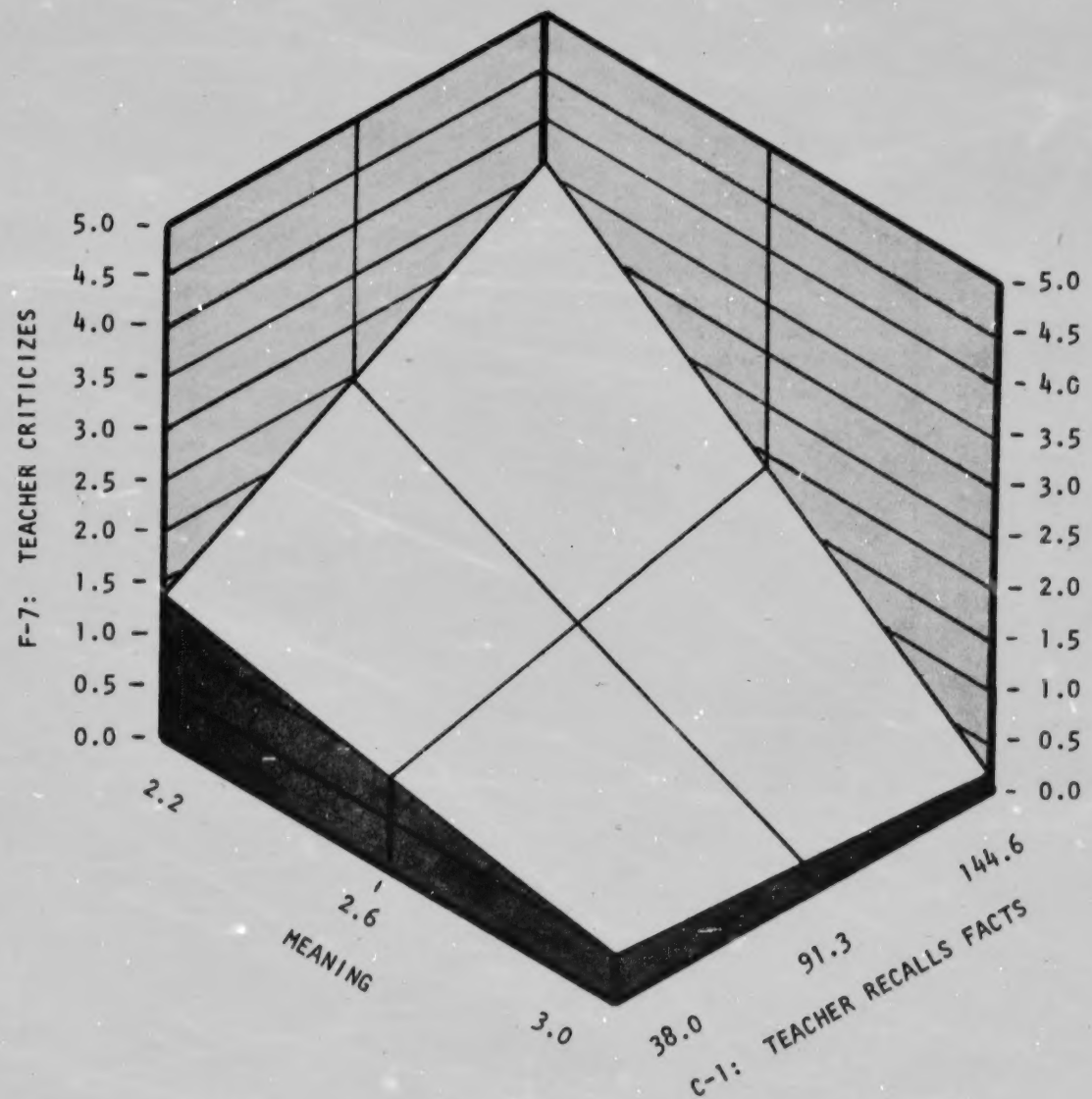


*p < .005

F-7: TEACHER CRITICIZES (ELEM.) (02)

F-7 = 0.56150 + 0.0849C1 - 0.029C1M

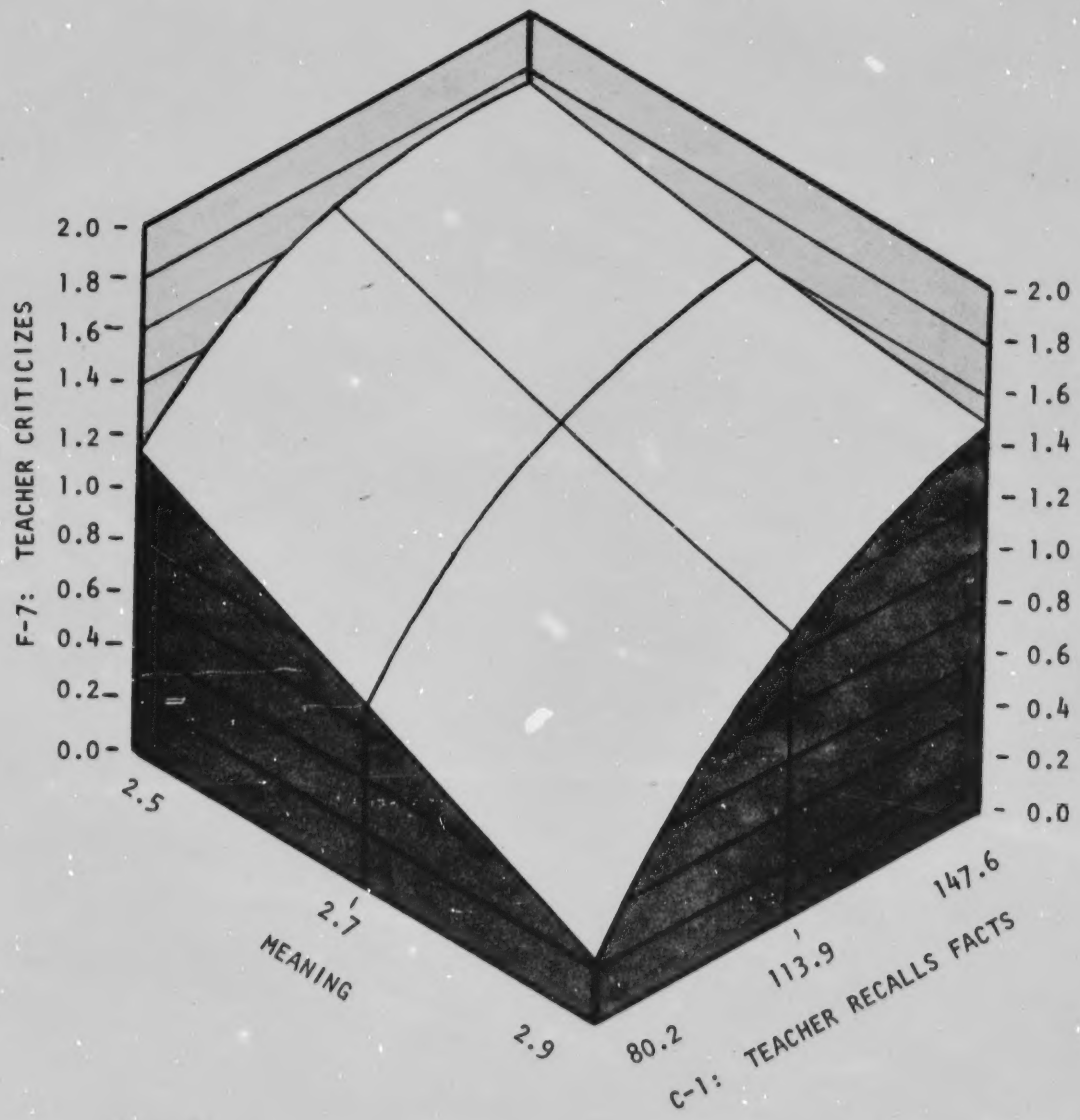
R^2 = 0.158 s_E = 1.444 $\underline{F}$ = 12.117



F-7: TEACHER CRITICIZES (SEC.)

$F\text{-}7 = 7.66677 - 3.871M - 0.0002C1C1 + 0.022C1M$

$R^2 = 0.087$ $S_E = 1.287$ $F = 2.987^*$

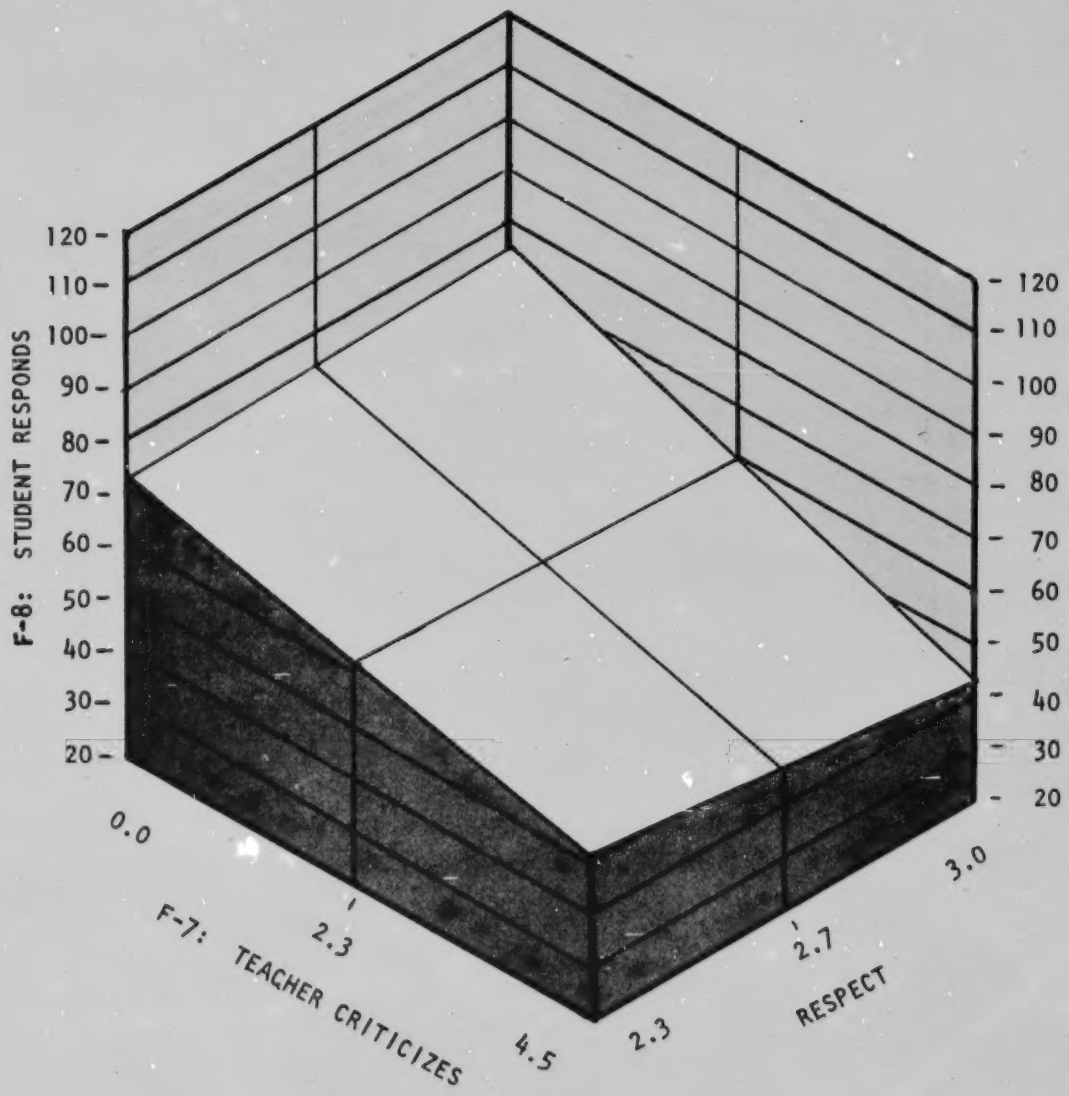


*p < .10

F-8: STUDENT RESPONDS (ELEM.) (02)

F-8 = 76.90346 - 2.454F7R

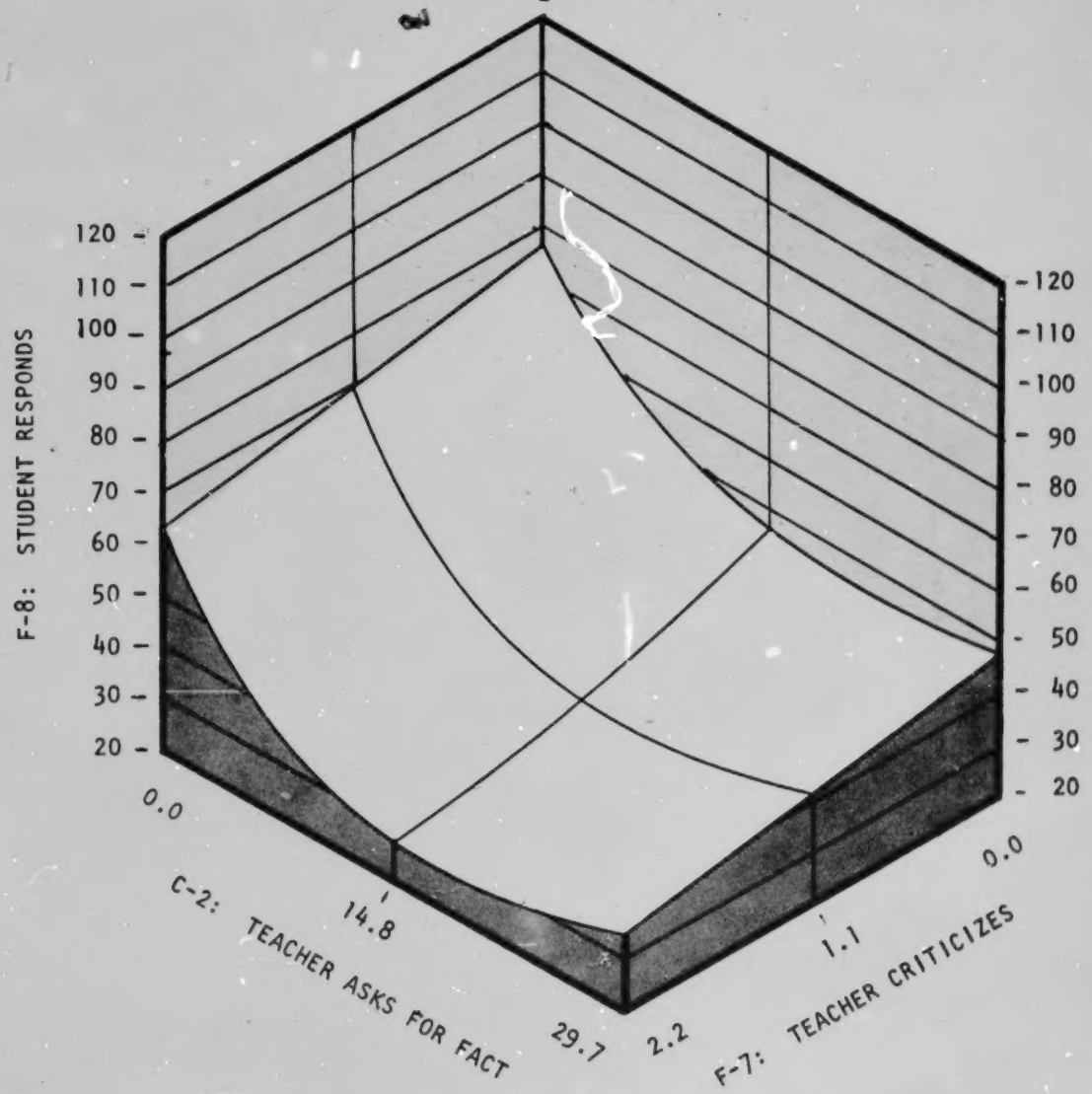
R^2 = 0.118 s_E = 25.616 $\underline{F}$ = 17.351



F-8: STUDENT RESPONDS (SEC.) (02)

$F\text{-}8 = 76.36852 - 6.0632F7 - 3.8560C2 + 0.0978C2C2$

$R^2 = 0.139$ $s_E = 34.569$ $\underline{F} = 3.0135^*$

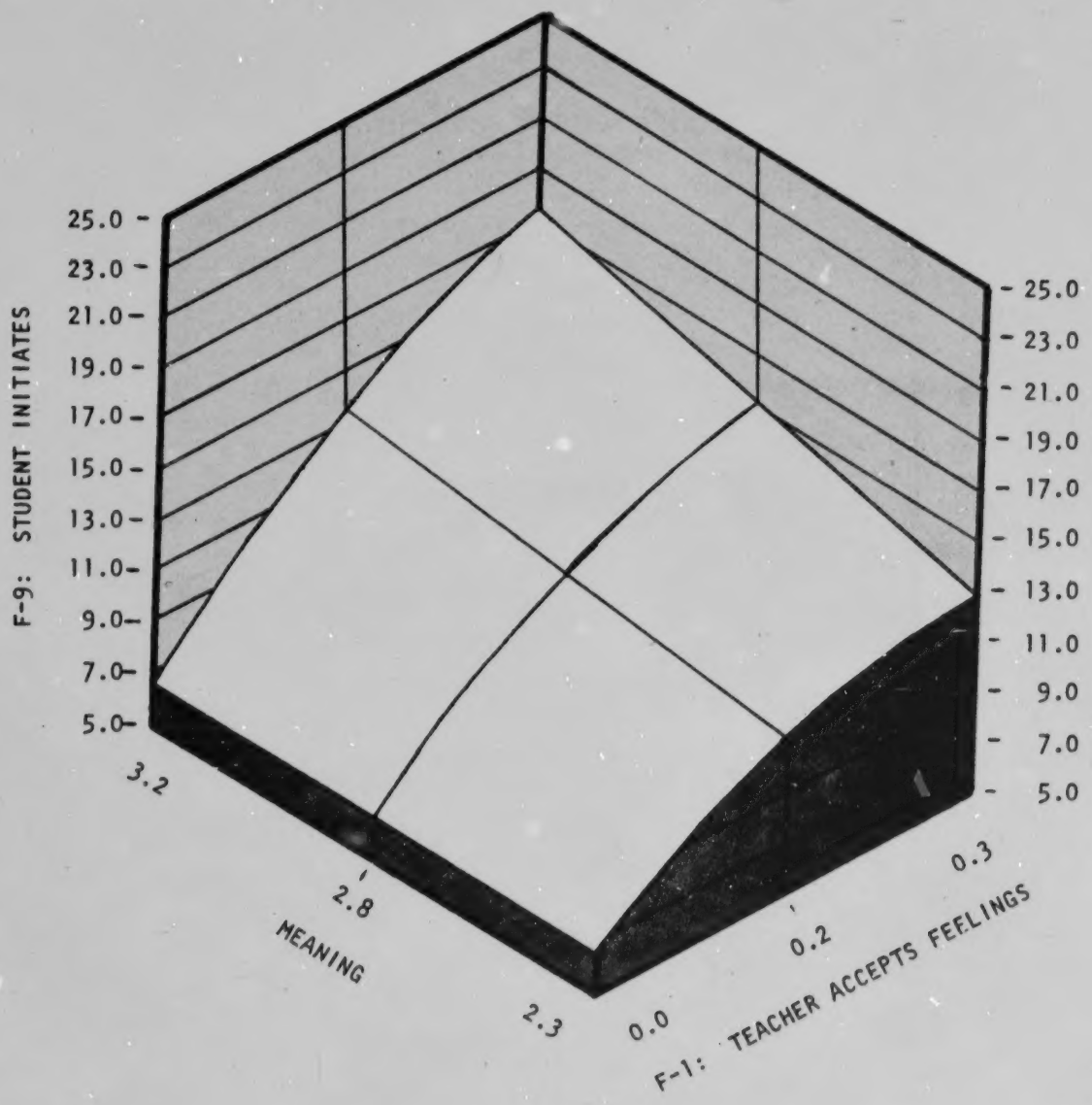


*p <.10

F-9: STUDENT INITIATES (ELEM.)

$F\text{-}9 = 6.59066 - 47.9076F1F1 + 15.013F1M$

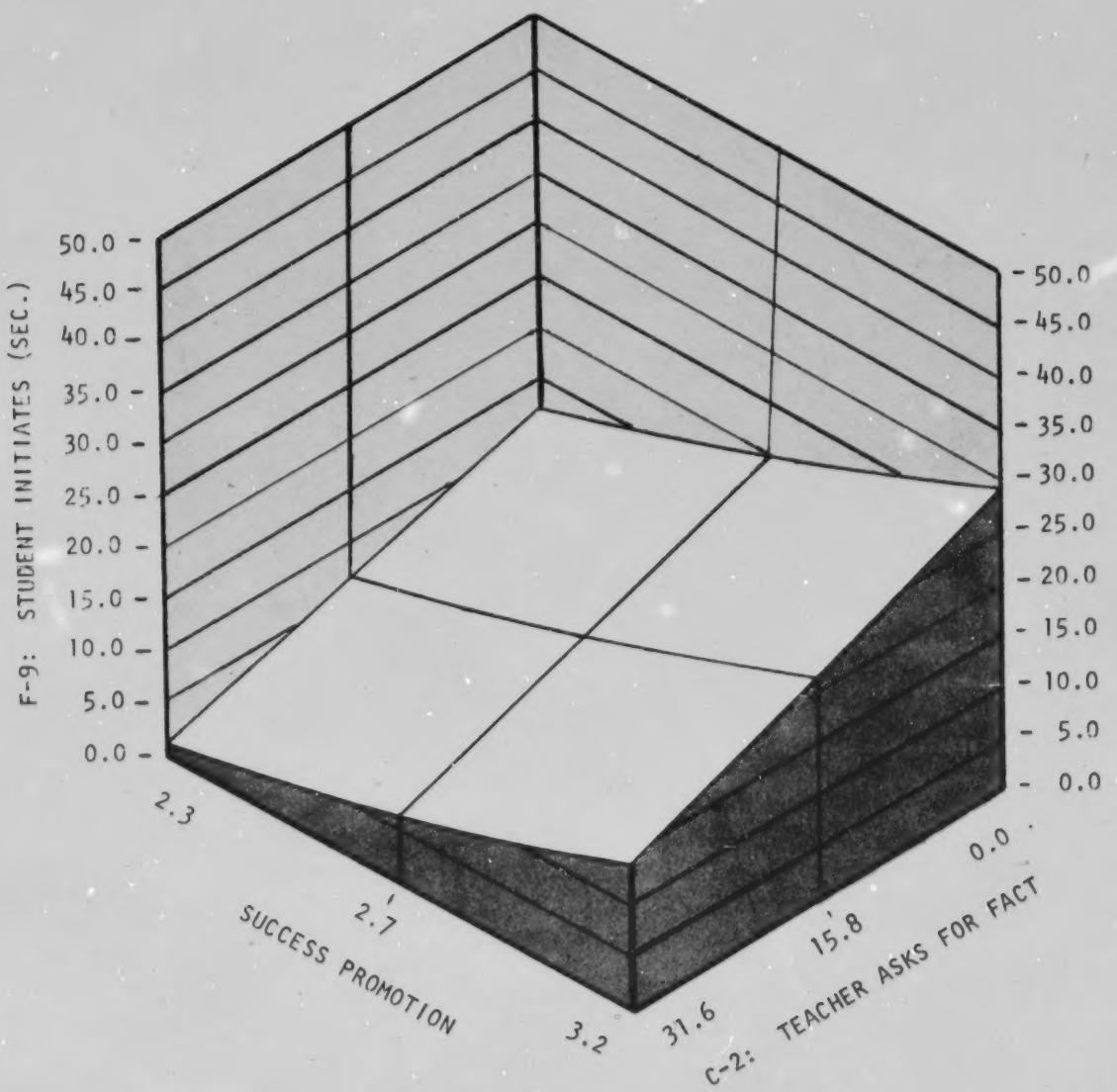
$R^2 = 0.172$ $S_E = 5.945$ $\underline{F} = 16.559$



F-9: STUDENT INITIATES (SEC.)

$F\text{-}9 = -5.07259 - 0.153C2SP + 0.334SPSP$

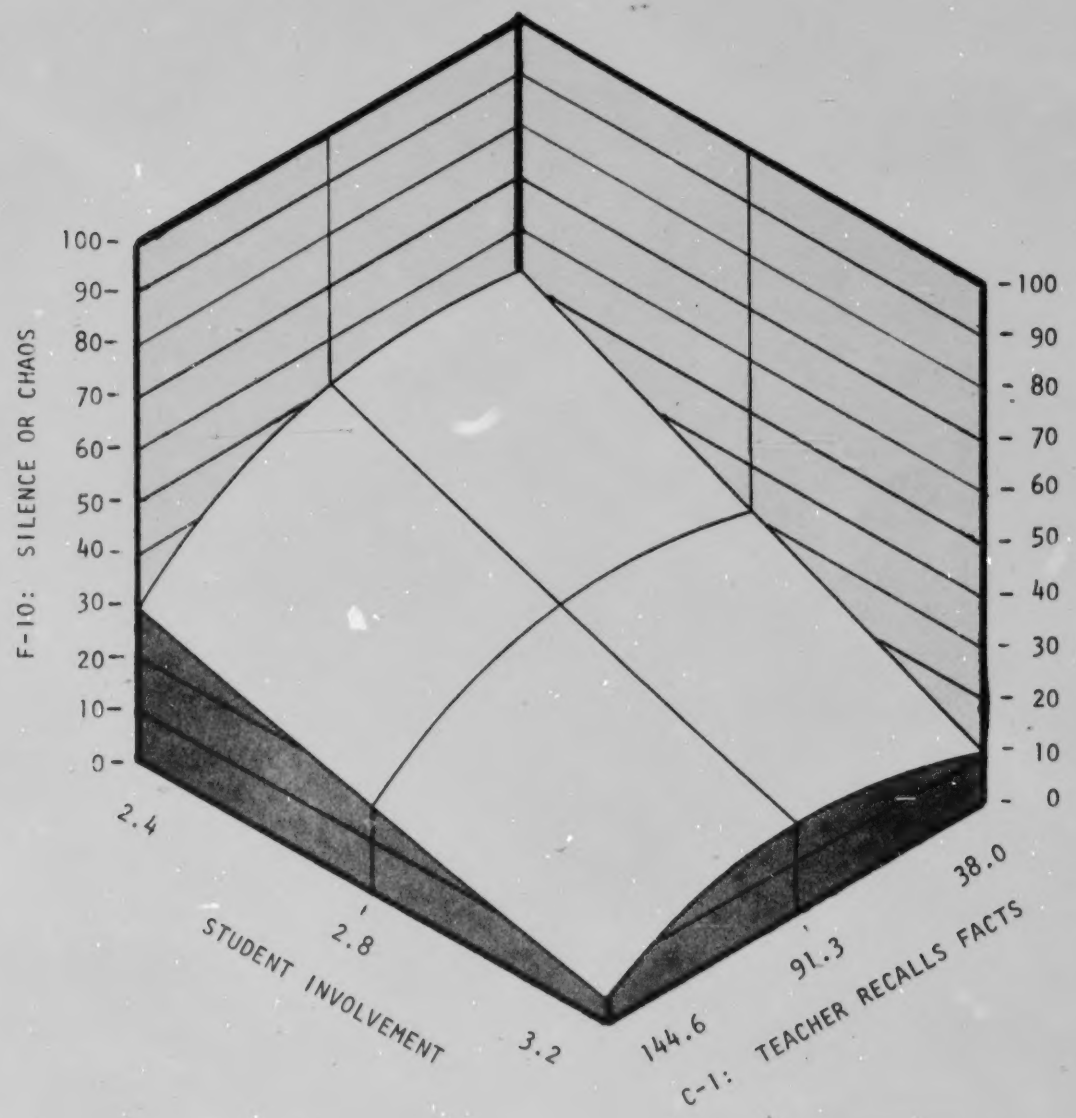
$R^2 = 0.189$ $S_E = 9.408$ $\underline{F} = 11.113$



F-10: SILENCE OR CHAOS (ELEM.) (02)

F-10 = 188.68338 - 61.130SI - 0.0037C1C1 + 0.1910C1SI

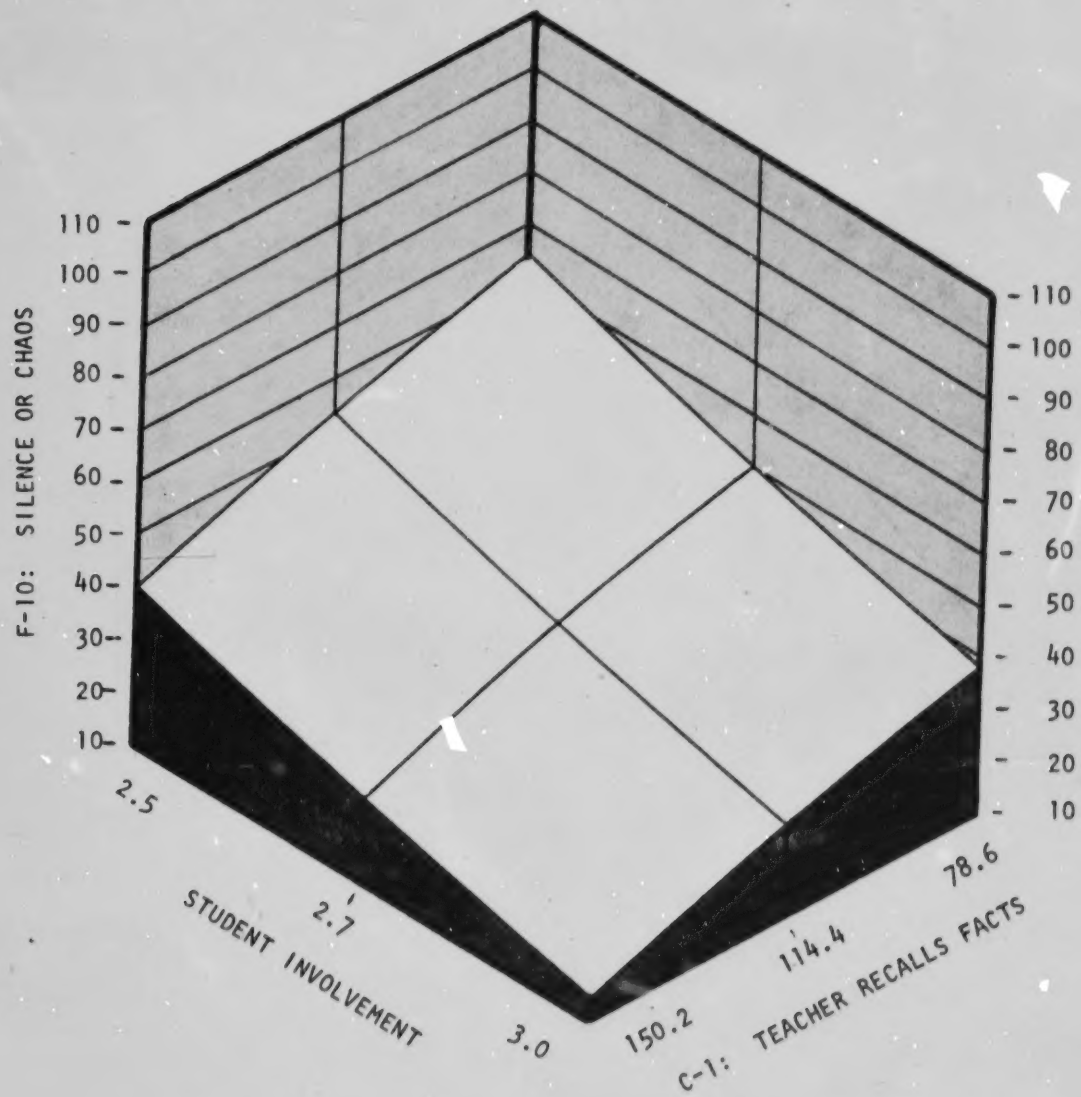
R^2 = 0.298 S_E = 14.27 F = 18.128



F-10: SILENCE OR CHAOS (SEC.) (02)

F-0 = 216.69711 - 57.22451 - 0.0015C1C1

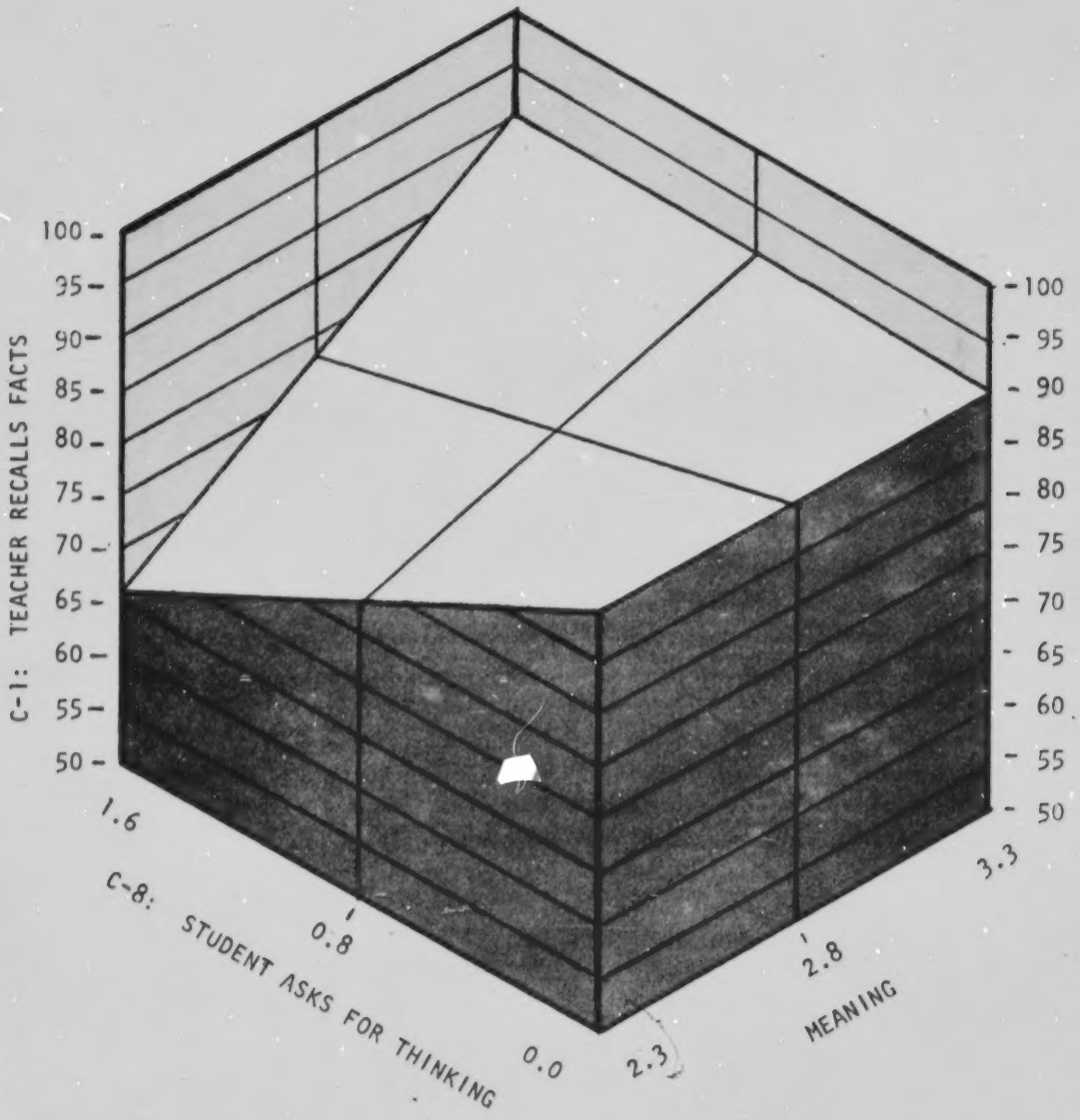
R^2 = 0.389 s_E = 21.261 F = 18.124



C-1: TEACHER RECALLS FACTS (ELEM.)

C-1 = 89.48824 - 49.429C8 + 15.095C8M

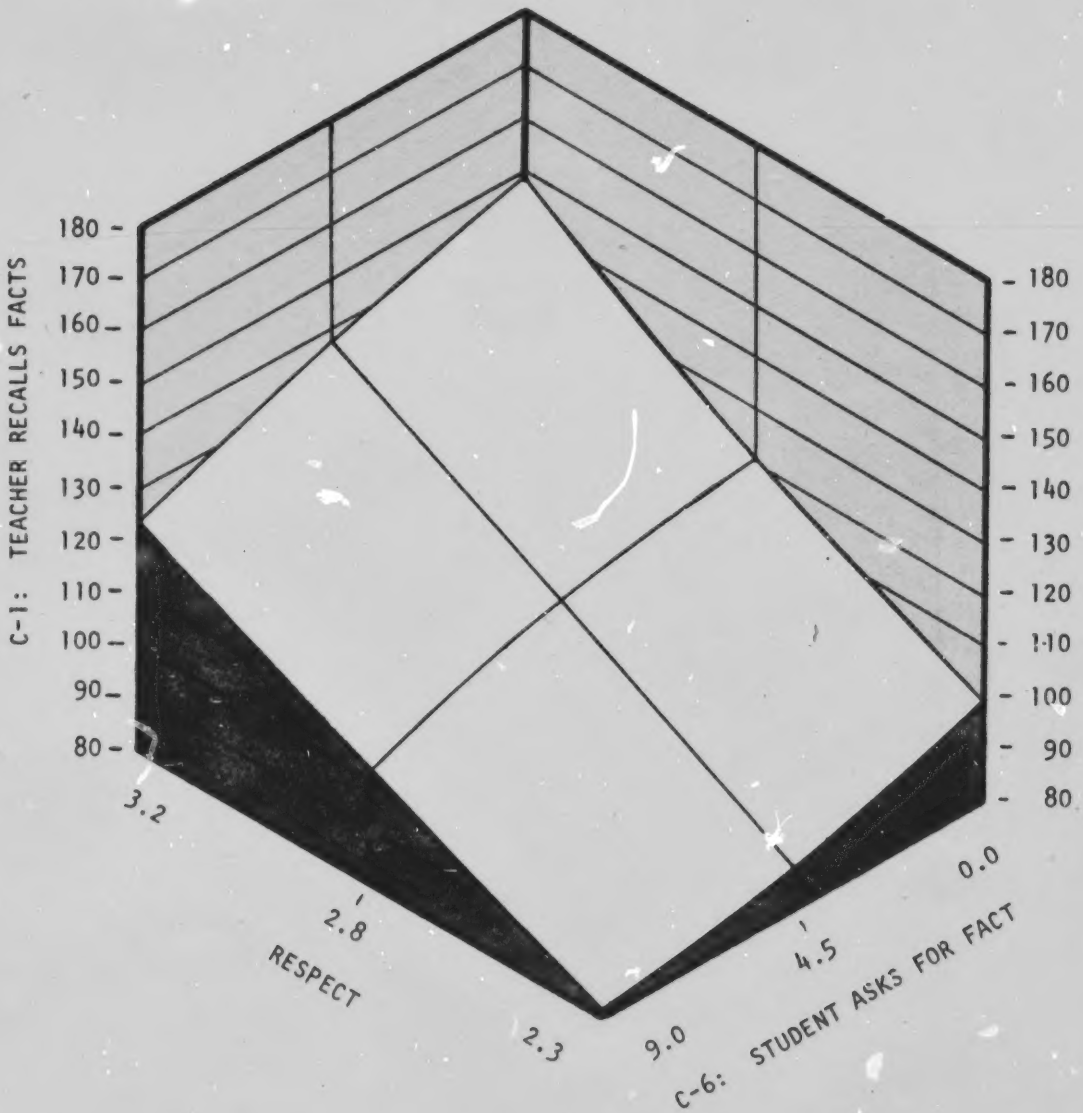
R^2 = 0.087 S_E = 23.014 $\underline{F}$ = 7.586



C-1: TEACHER RECALLS FACTS (SEC.)

C-1 = 37.88954 - 0.738C6R + 10.64RR

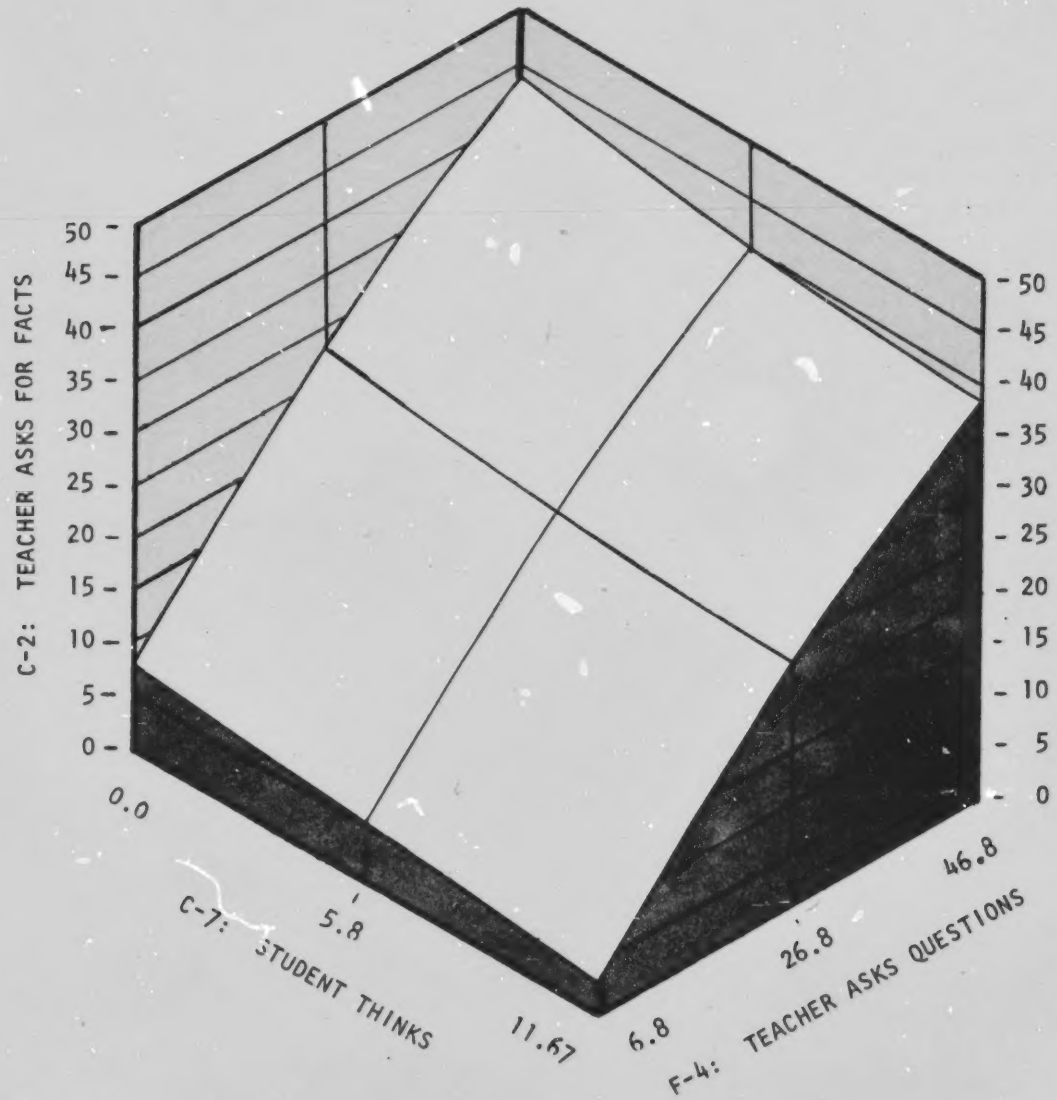
R^2 = 0.150 s_E = 31.369 $\underline{F}$ = 8.416



C-2: TEACHER ASKS FOR FACTS (ELEM.)

$C\text{-}2 = 0.15662 + 1.2155F4 - 0.6347C7 - 0.0061F4F4 + 0.0176C7C7$

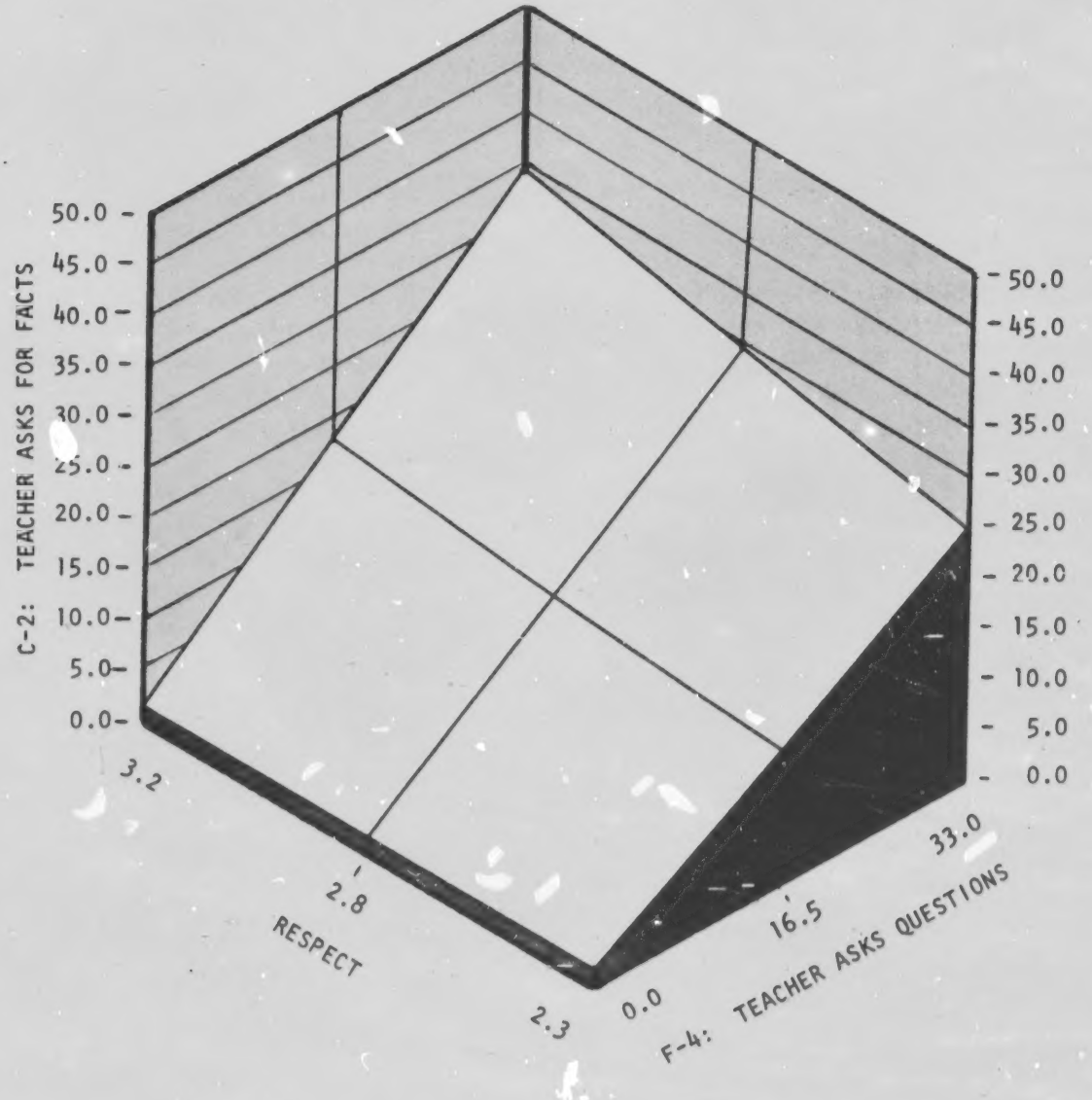
$R^2 = 0.847$ $\quad S_E = 3.663$ $\quad \underline{F} = 217.465$



C-2: TEACHER ASKS FOR FACTS (SEC.)

$C\text{-}2 = 1.76212 + 0.303F4R$

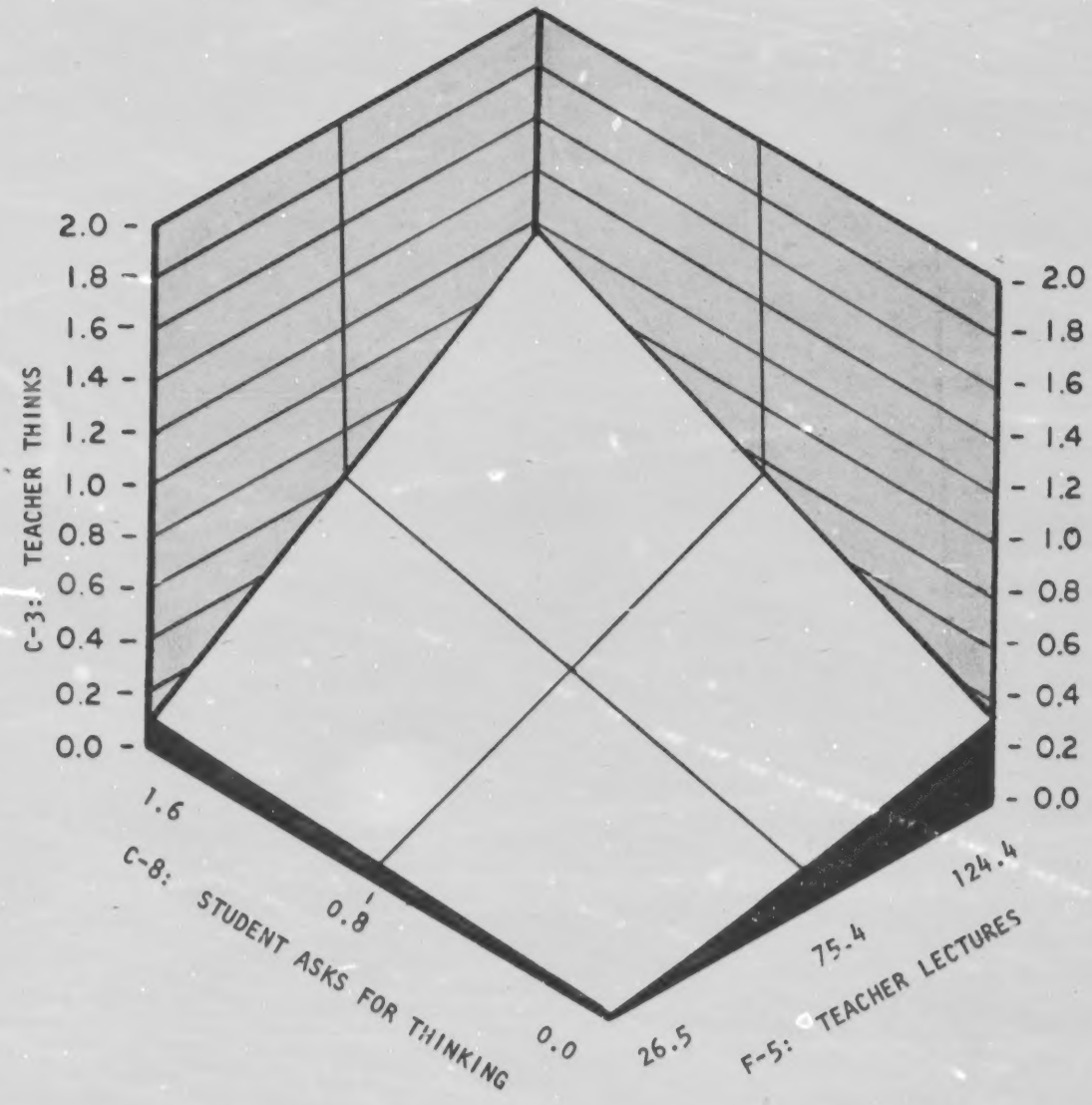
$R^2 = 0.849$ $\quad s_E = 3.241$ $\quad \underline{F} = 541.585$



C-3: TEACHER THINKS (ELEM.)

C-3 = -0.04657 + 0.021C2S1

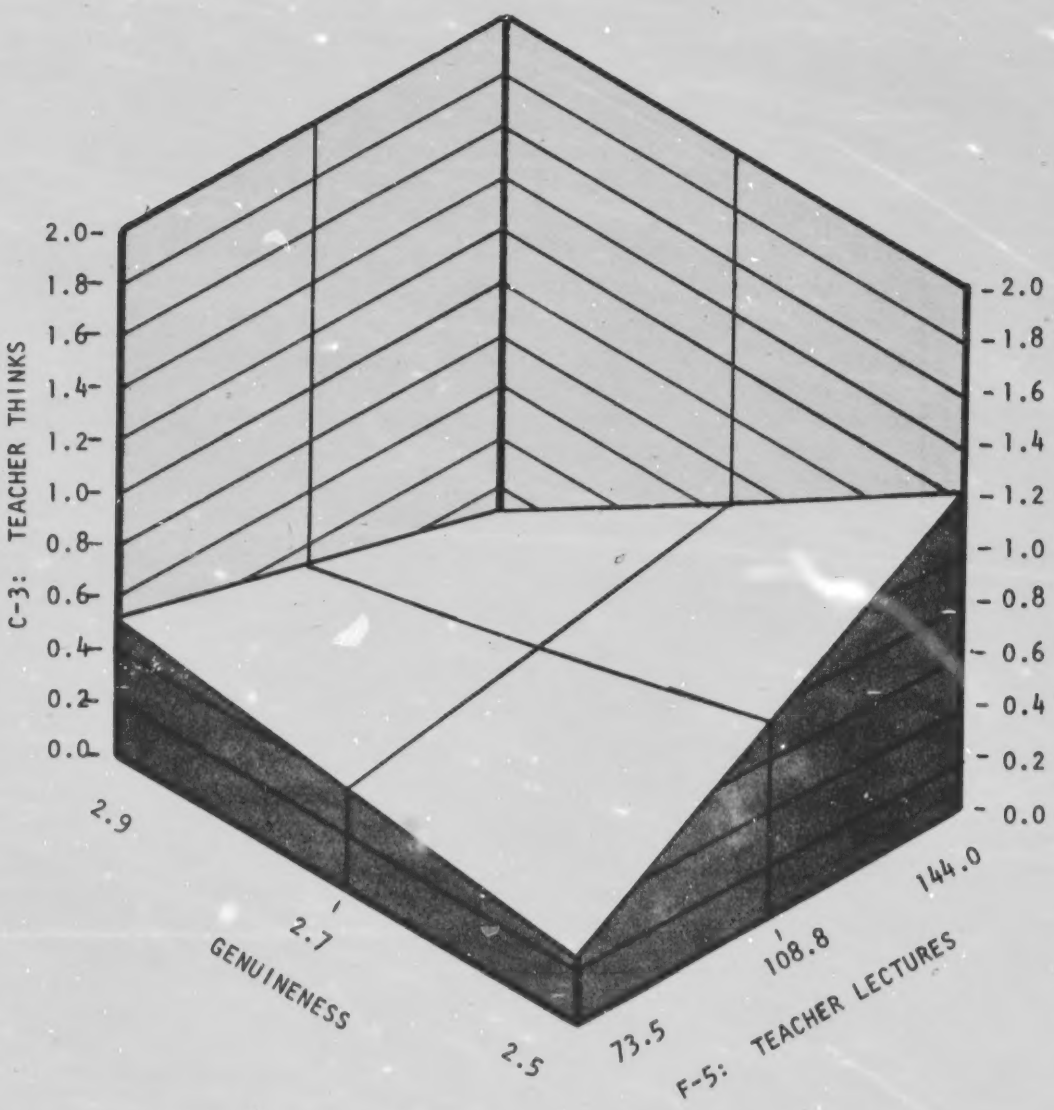
R^2 = 0.215 s_E = 0.577 $\underline{F}$ = 43.863



C-3: TEACHER THINKS (SEC.)

$C\text{-}3 = -10.52915 + 0.1259F5 + 3.920G - 0.450F5G$

$R^2 = 0.117$ $\quad s_E = 1.088$ $\quad \underline{F} = 4.161^*$

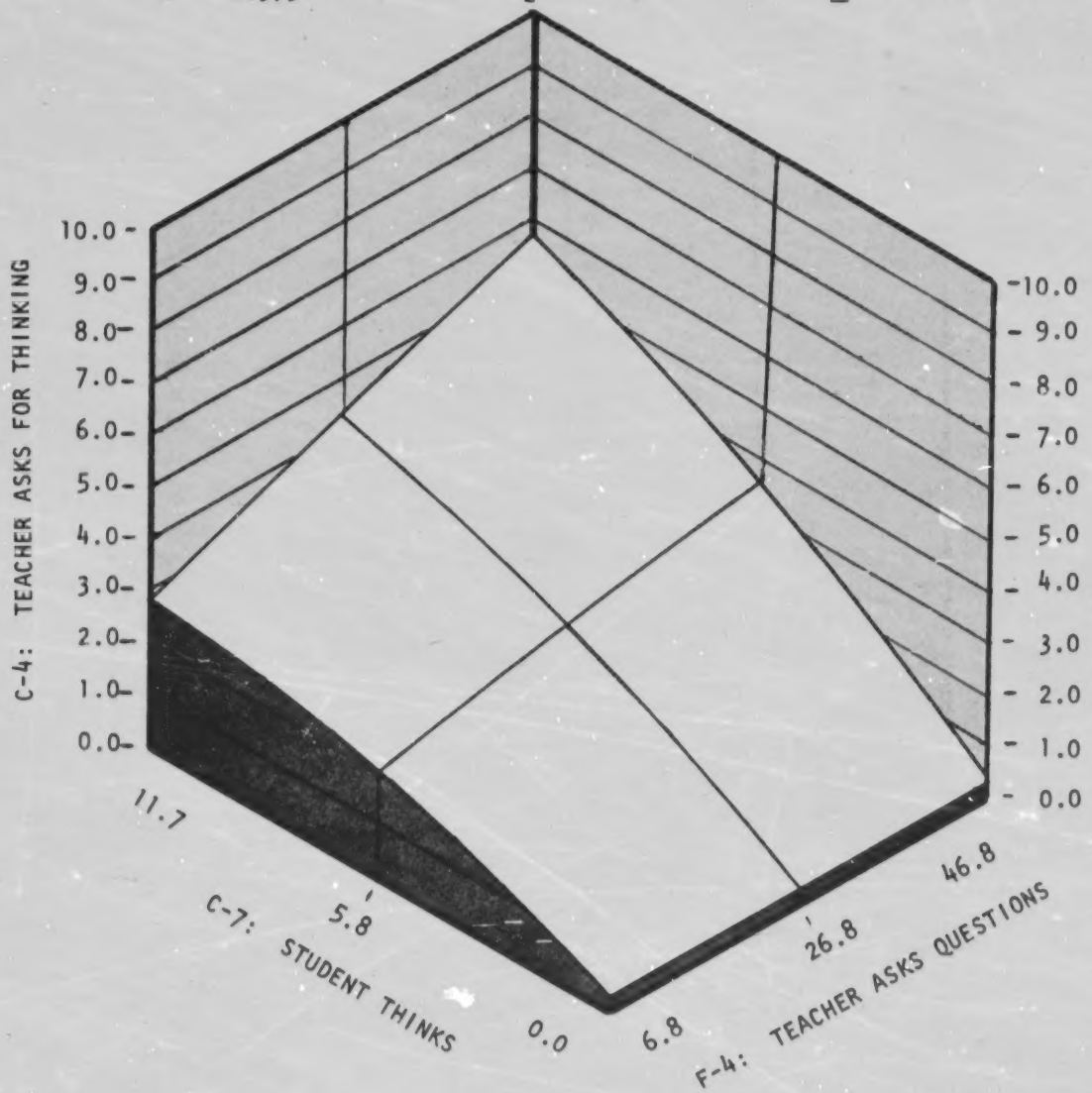


*p< .025

C-4: TEACHER ASKS FOR THINKING (ELEM.)

$C\text{-}4 = 0.20263 + 0.3779C7 + 0.0065F4C7 - 0.0171C7C7$

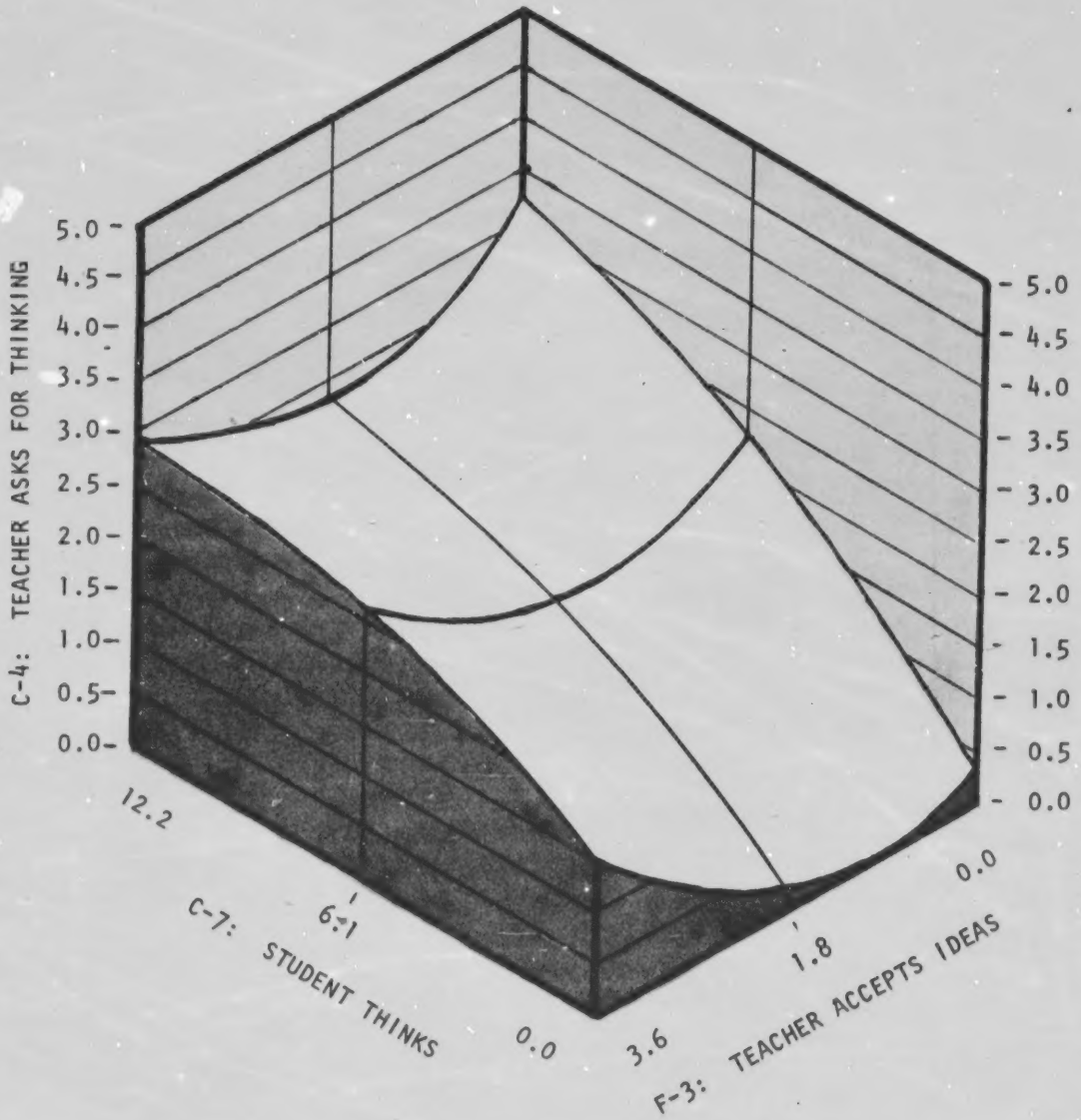
$R^2 = 0.579$ $S_E = 1.231$ $F = 72.379$



C-4: TEACHER ASKS FOR THINKING (SEC.)

$$C\text{-}4 = 0.34361 - 0.4976F3 + 0.3821C7 + 0.2249F3F3 - 0.0342F3C7 - 0.0119C7C7$$

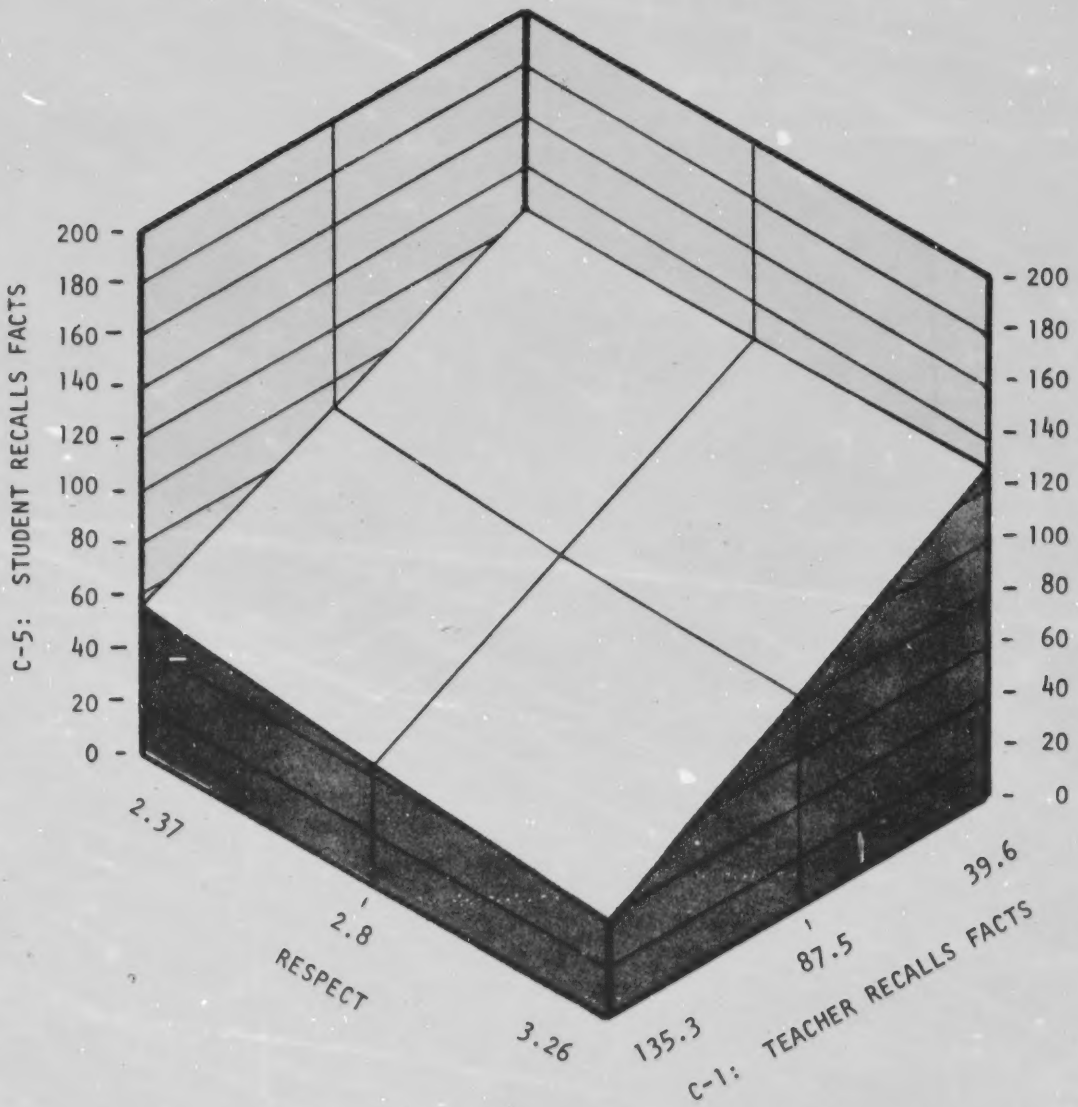
$R^2 = 0.377$ $S_E = 1.371$ $F = 11.155$



C-5: STUDENT RECALLS FACTS (ELEM.)

C-5 = 134.39226 - 0.295C1R + 3.090RR

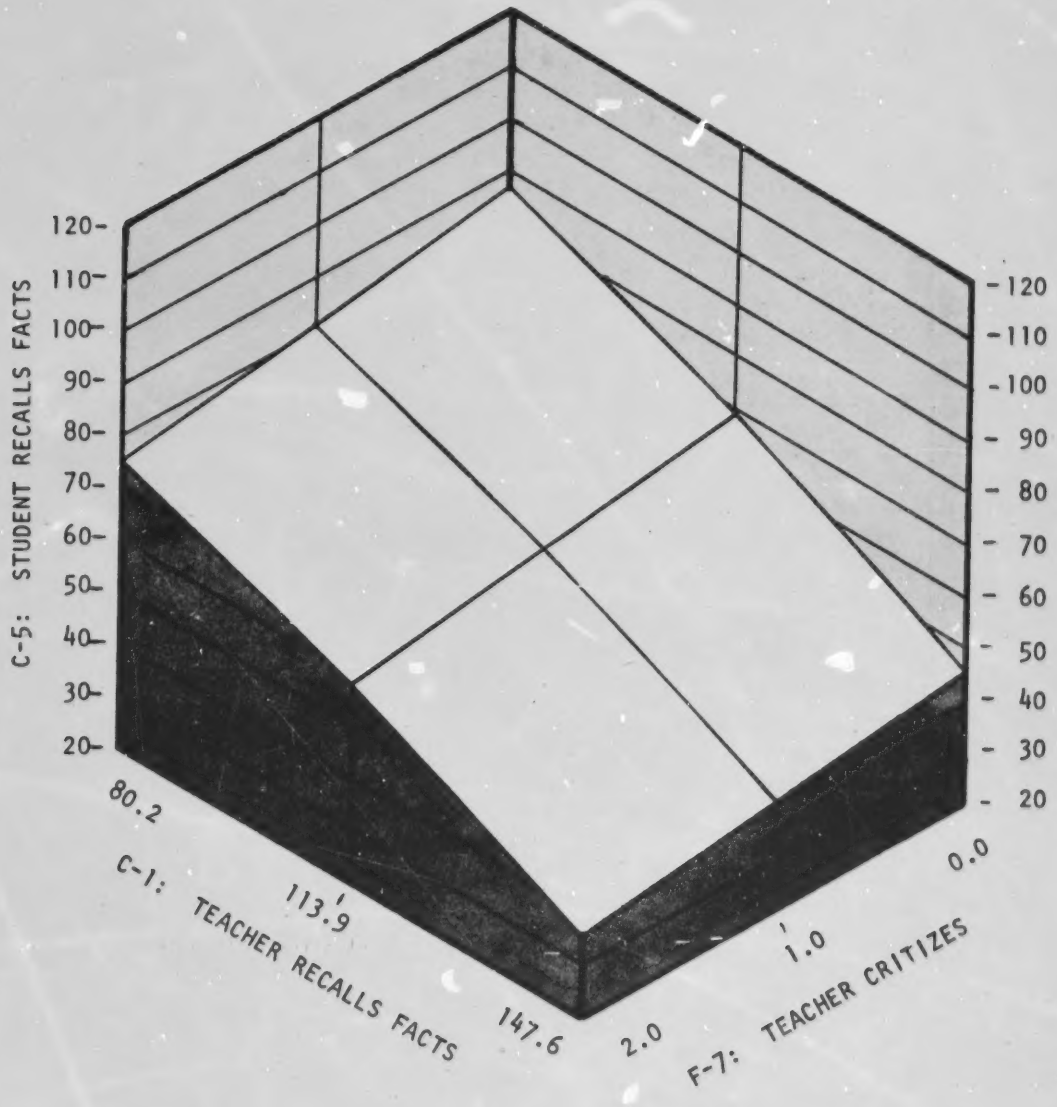
R^2 = 0.578 s_E = 16.865 $\underline{F}$ = 108.965



C-5: STUDENT RECALLS FACTS (SEC.)

C-5 = 103.48167 - 5.8125F7 - 0.0026C1C1

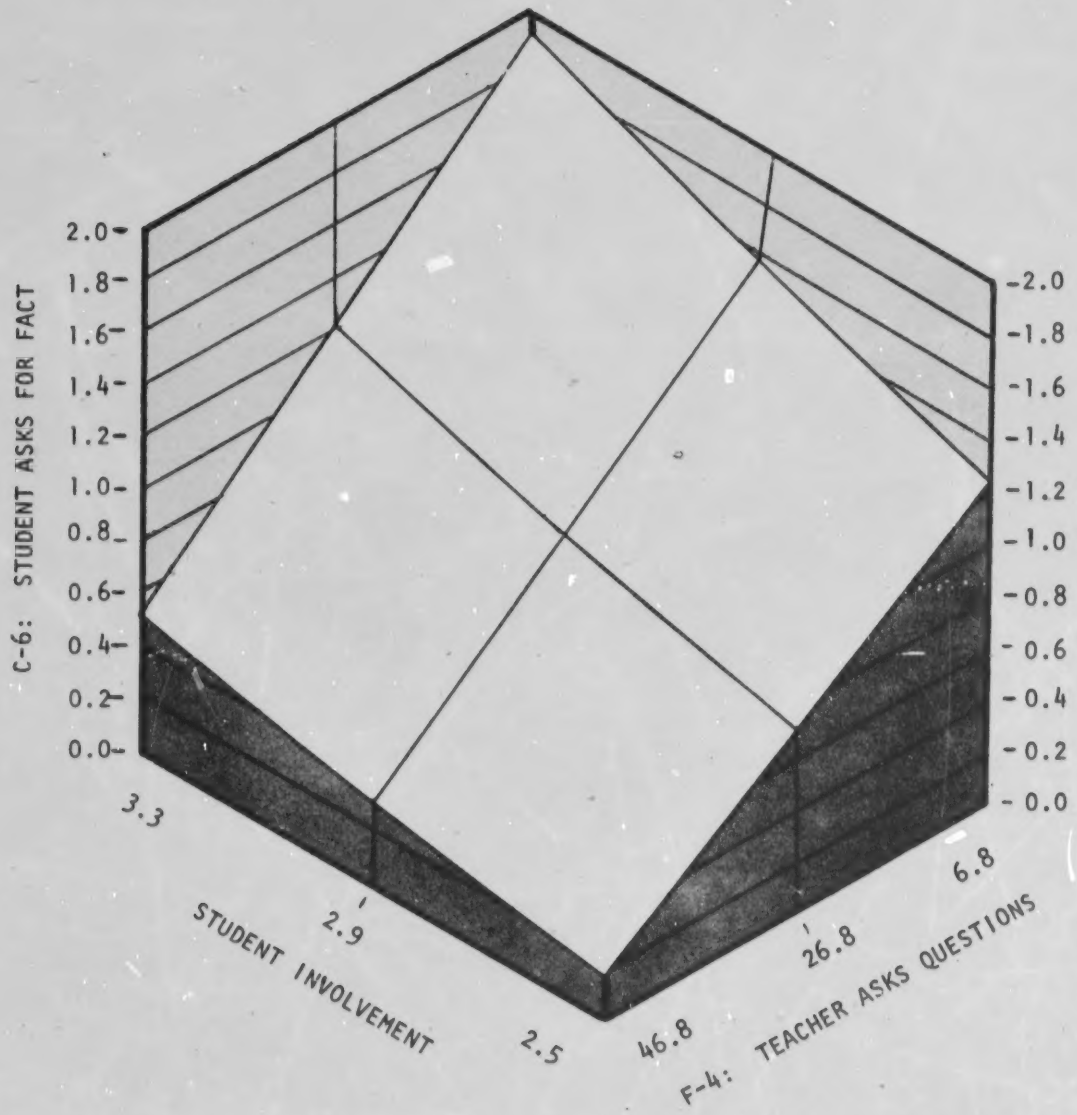
R^2 = 0.377 s_E = 27.310 $\underline{F}$ = 28.780



C-6: STUDENT ASKS FOR FACT

$C\text{-}6 = 0.37964 - 0.011F4SI + 0.170SISI$

$R^2 = 0.067$ $S_E = 1.127$ $F = 5.789^*$

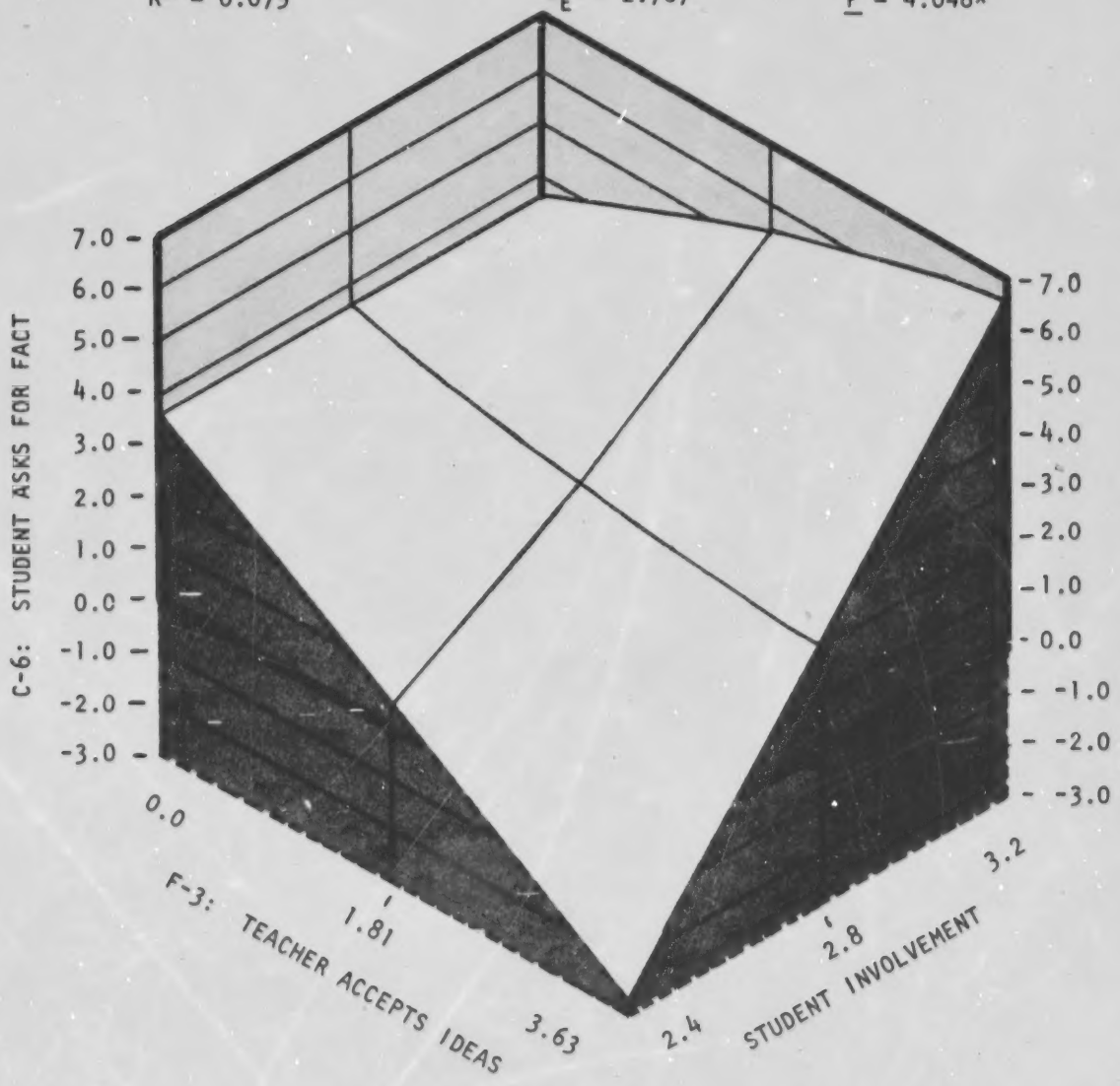


*p <.005

C-6: STUDENT ASKS FOR FACT (SEC.) (01)

C-6 = 3.47762 - 9.8178F3 + 3.360 F3S1

R^2 = 0.079 s_E = 2.787 $\underline{F}$ = 4.048*

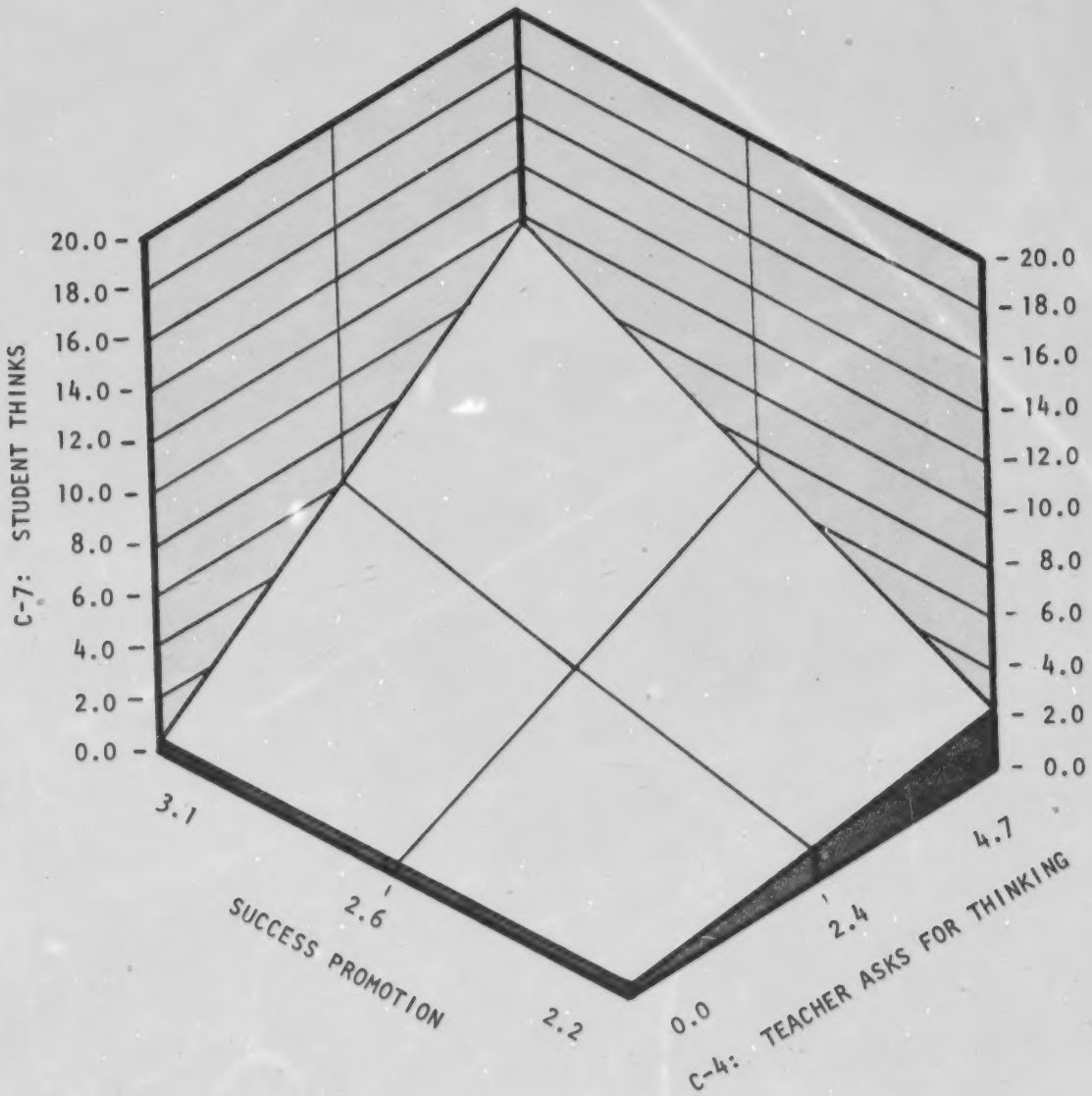


*p < .025

C-7: STUDENT THINKS (ELEM.) (02)

C-7 = 0.30705 - 4.5038C4 + 2.278C4SP

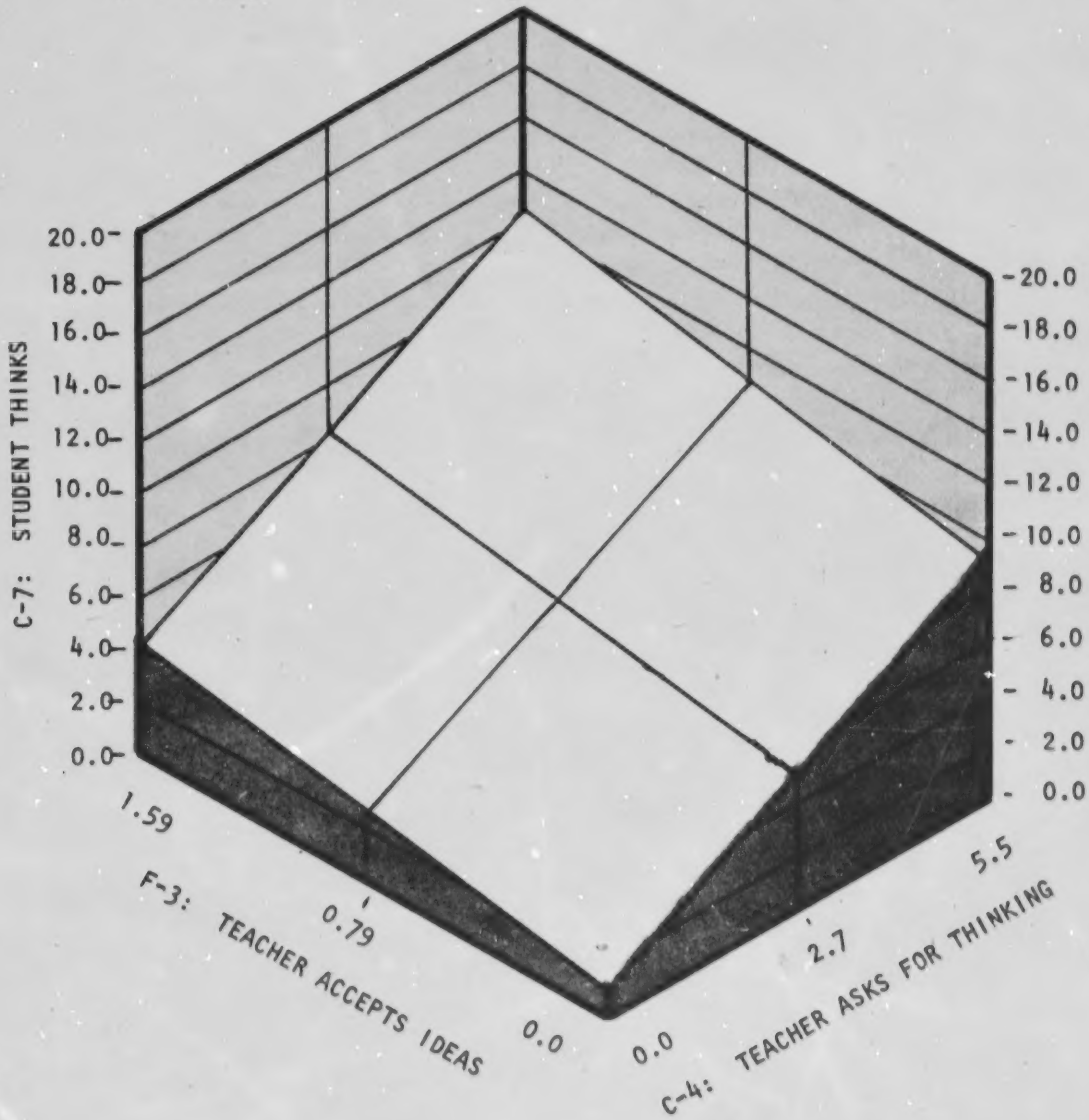
R^2 = 0.593 s_E = 2.153 $\underline{F}$ = 94.269



C-7: STUDENT THINKS (SEC.) (02)

C-7 = 0.93802 + 2.0125F3 + 1.5133C4

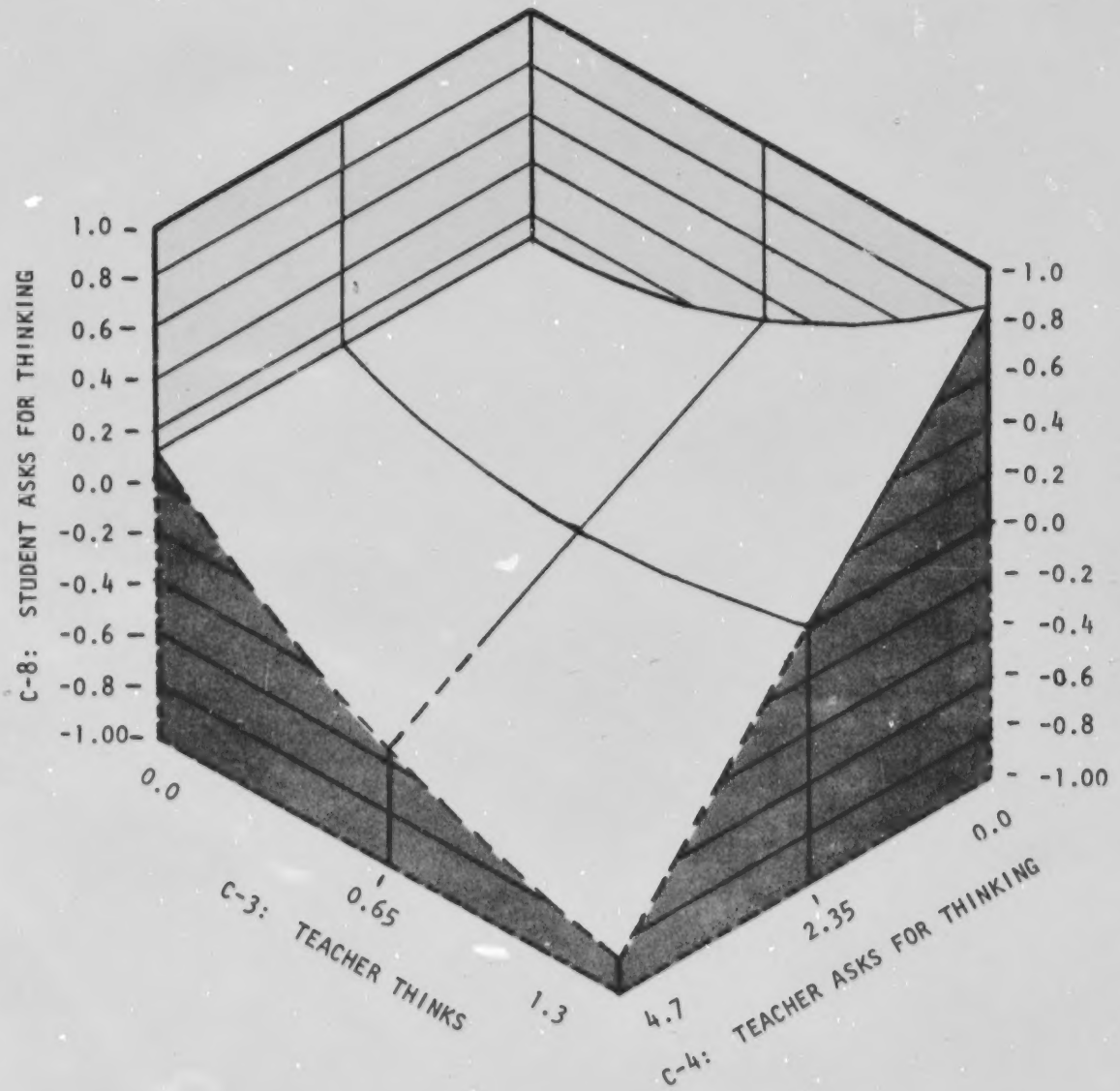
R^2 = 0.503 S_E = 3.359 $\underline{F}$ = 28.829



C-8: STUDENT ASKS FOR THINKING (ELEM.) (02)

$C\text{-}8 = 0.10925 + 0.4549C3C3 - 0.2922C3C4$

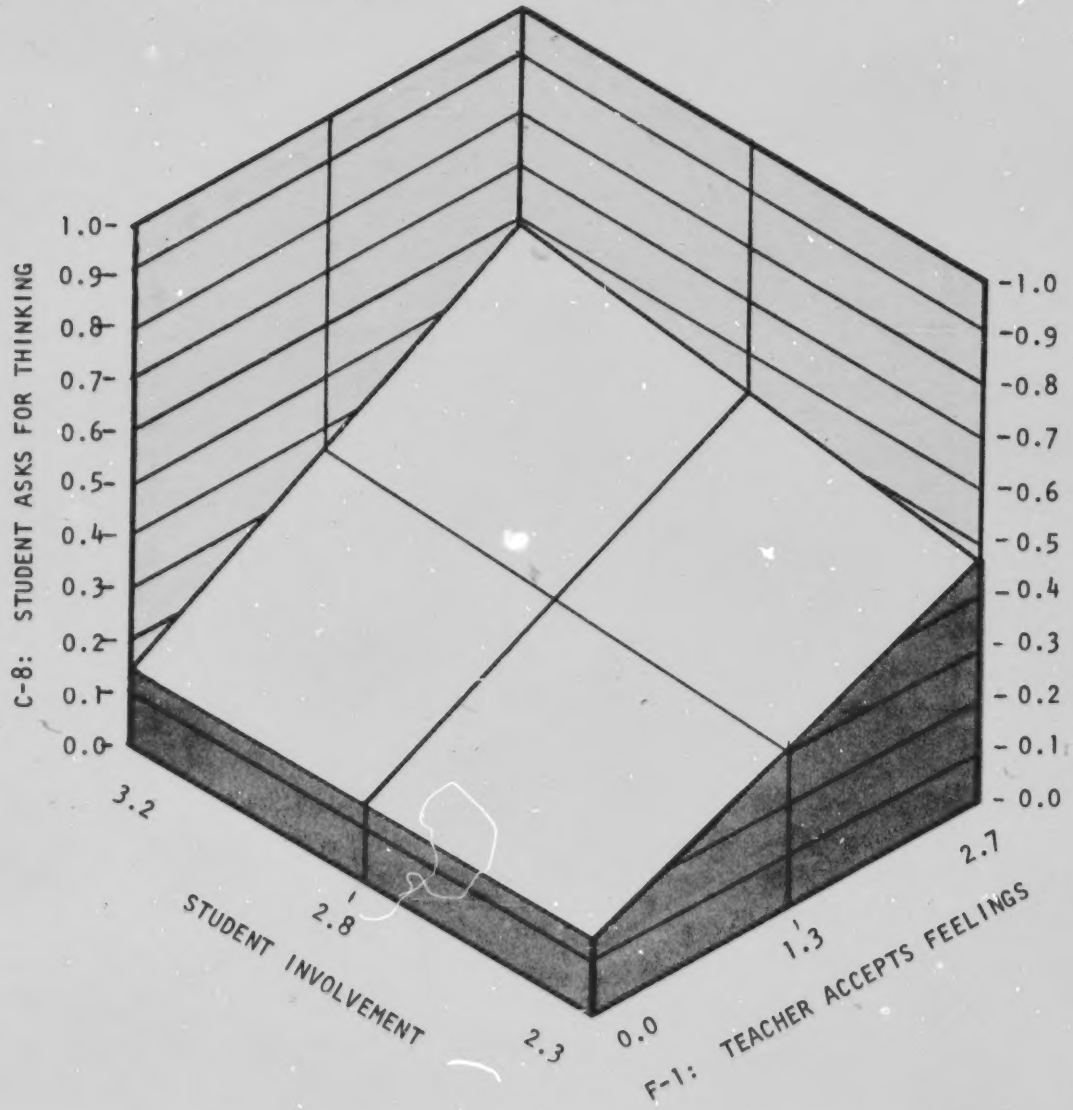
$R^2 = 0.741$ $s_E = 0.431$ $\underline{F} = 132.123$



C-8: STUDENT ASKS FOR THINKING (SEC.) (02)

$C\text{-}8 = 0.13515 + 0.0540F1SI$

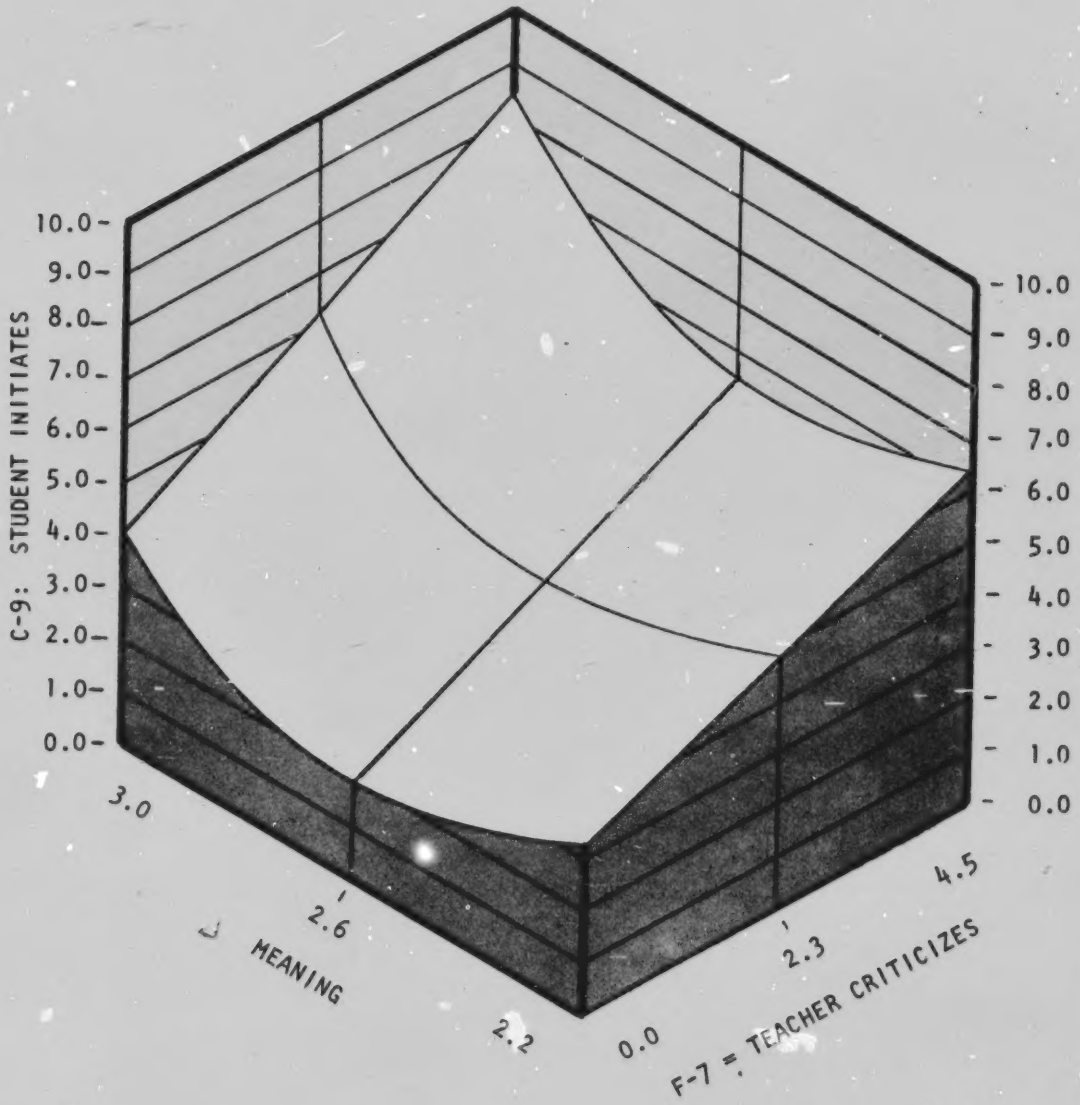
$R^2 = 0.244$ $S_E = 0.335$ $F = 18.689$



C-9: NON-COGNITIVE BEHAVIOR (ELEM.) (02)

$C\text{-}9 = 71.61244 - 54.513M + 0.322F7M + 10.65MM$

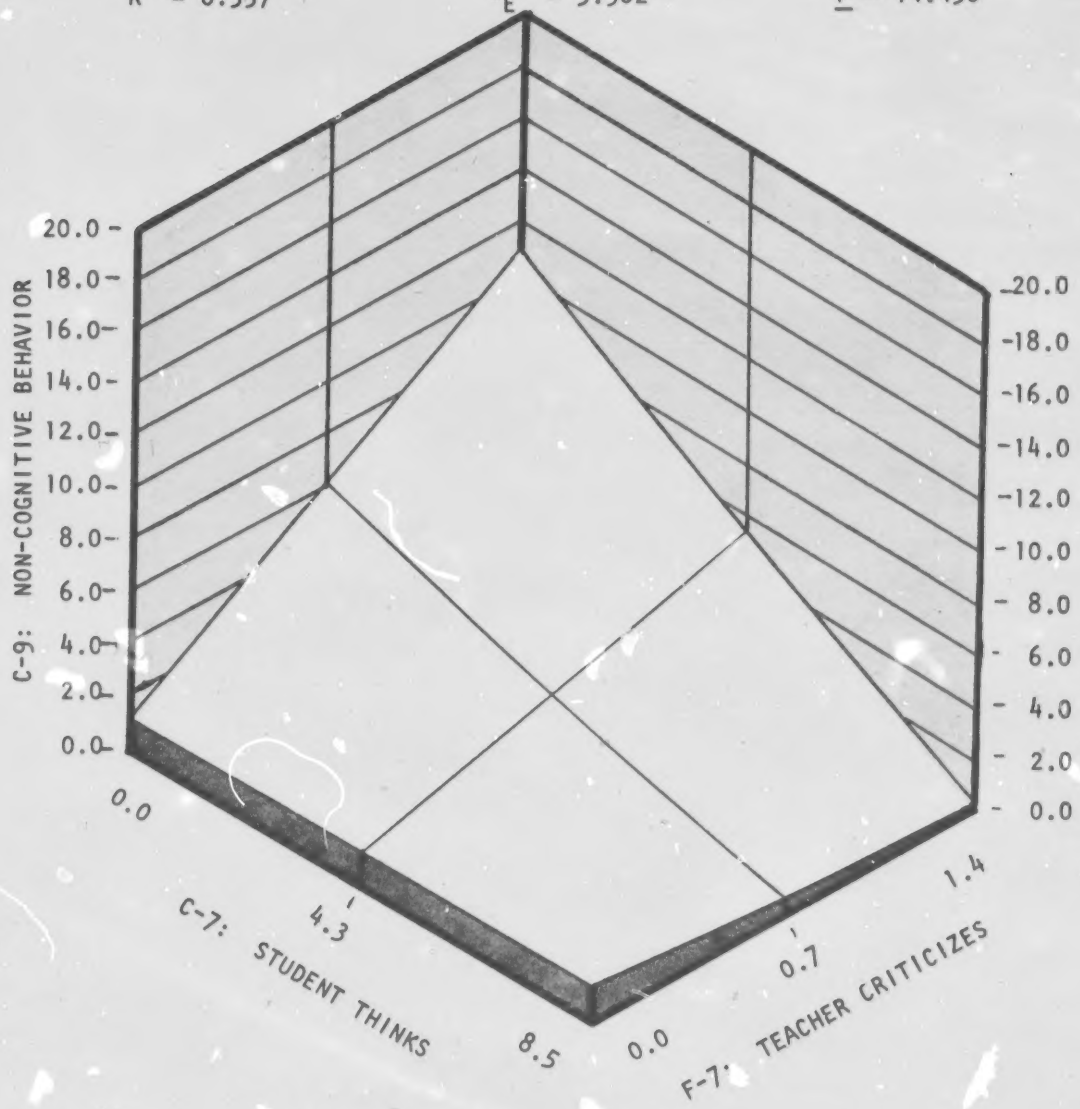
$R^2 = 0.308$ $s_E = 2.307$ $F = 19.063$



C-9: NON-COGNITIVE BEHAVIOR (SEC.) (02)

$C\text{-}9 = 1.17399 + 7.3162F7 - 0.9498F7C7$

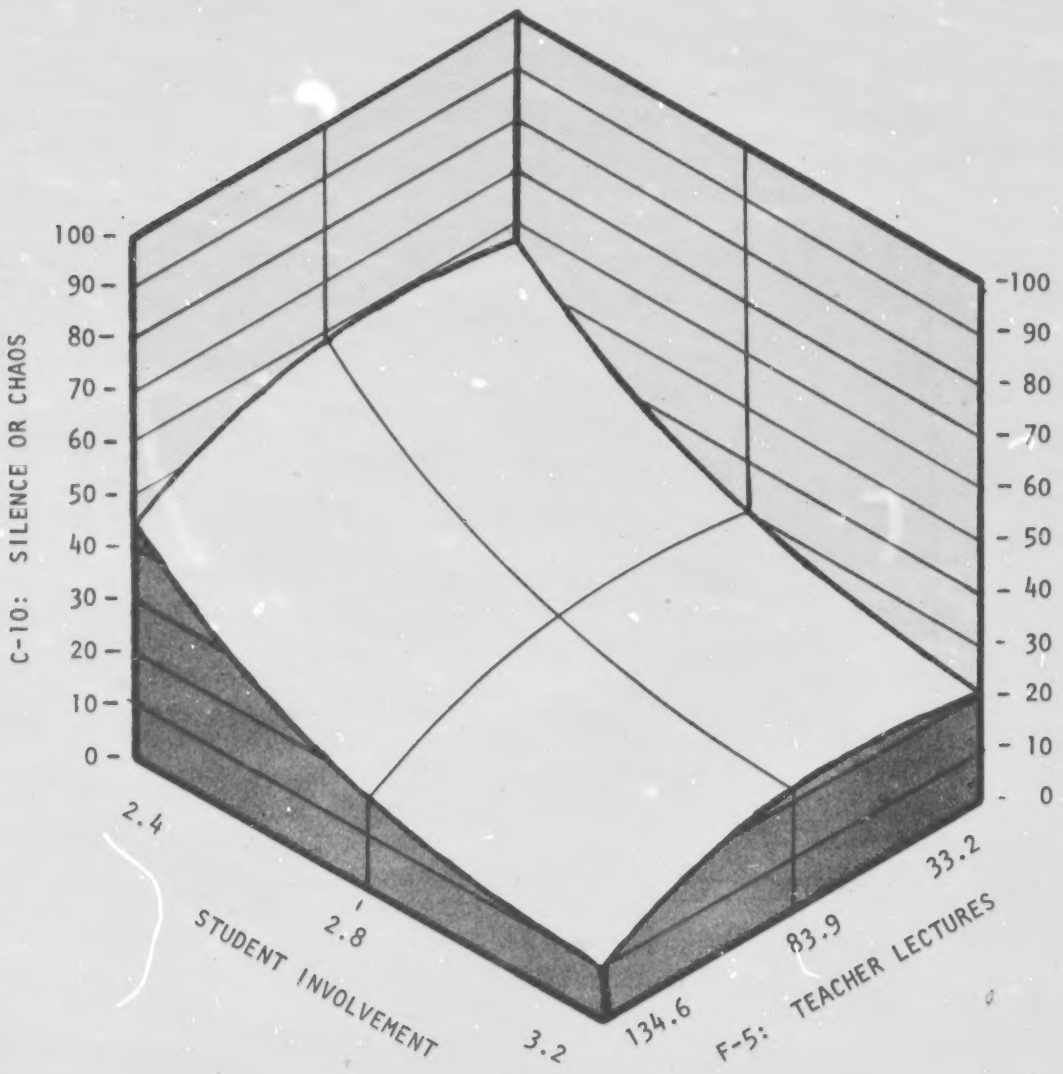
$R^2 = 0.337$ $S_E = 5.962$ $F = 14.456$



C-10: SILENCE OR CHAOS (ELEM.) (02)

$C\text{-}10 = 647.23755 + 0.3774F5 - 398.271SI - 0.0030F5F5 + 62.48SISI$

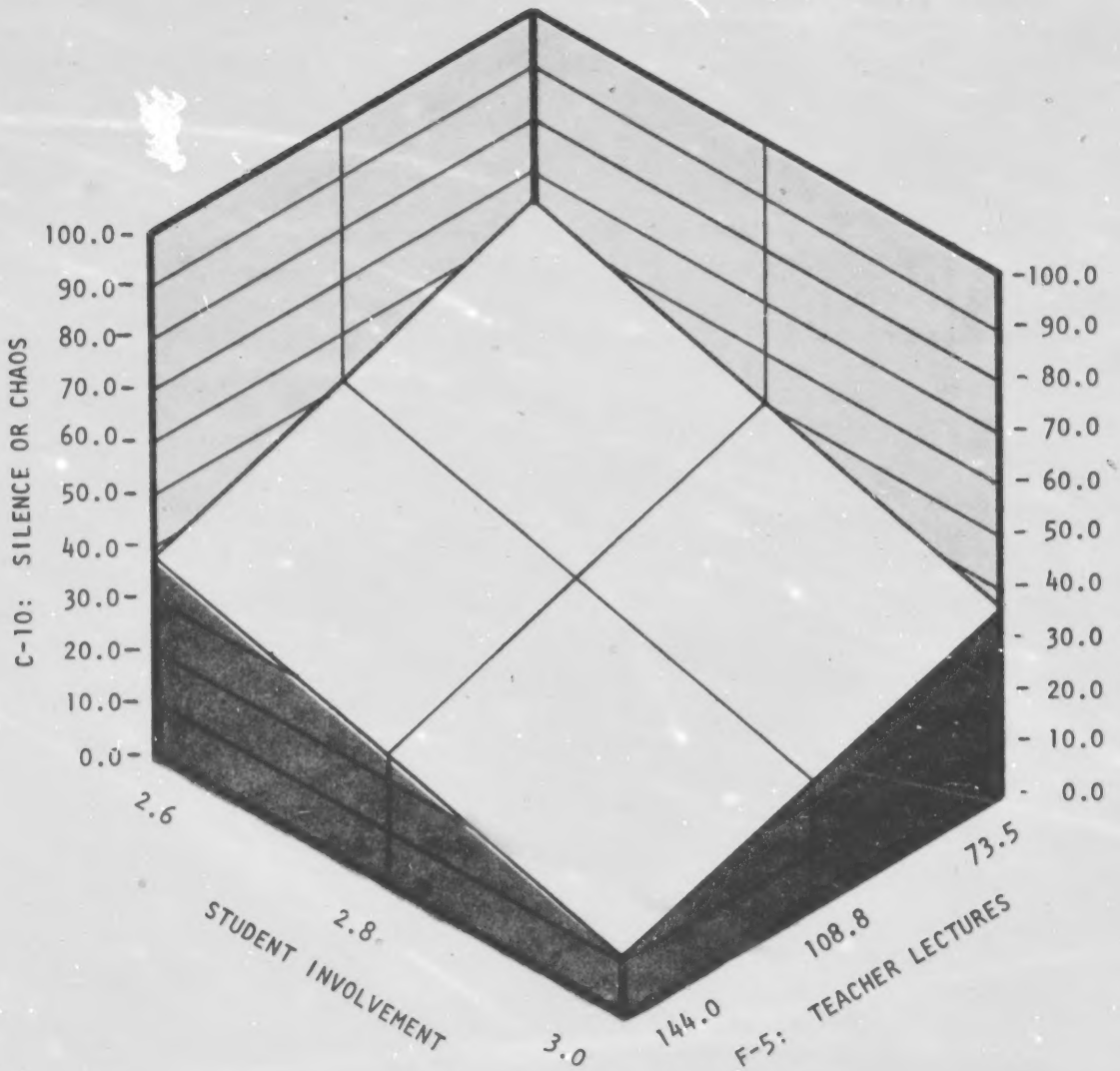
$R^2 = 0.353$ $\quad s_E = 13.637$ $\quad \underline{F} = 17.314$



C-10: SILENCE OR CHAOS (SEC.)

C-10 = 164.96225 - 0.3639F5 - 11.110SISI

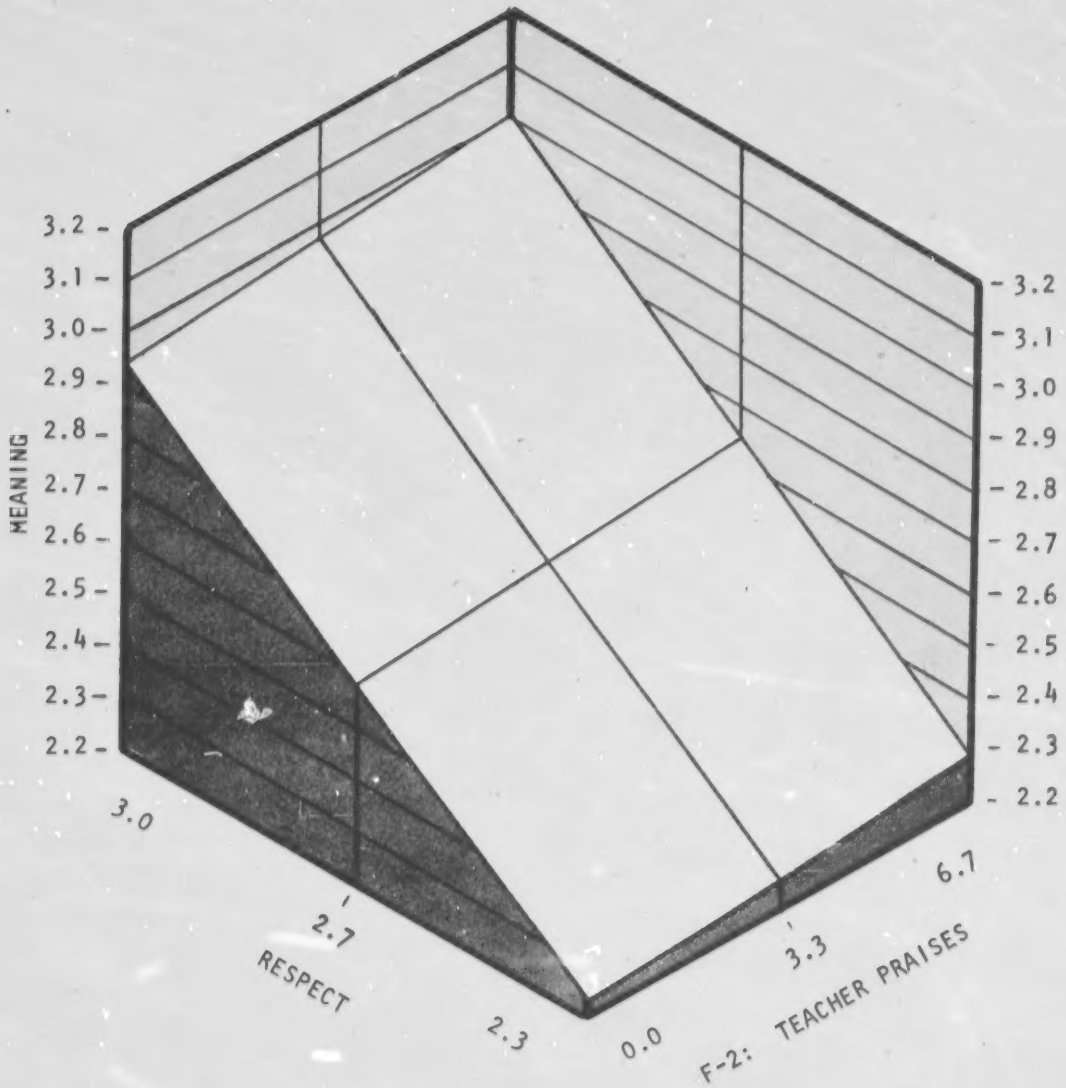
R^2 = 0.367 s_E = 25.018 $\underline{F}$ = 27.635



MEANING (ELEM.) (02)

$M = .14441 + 0.9191R + 0.0102F2$

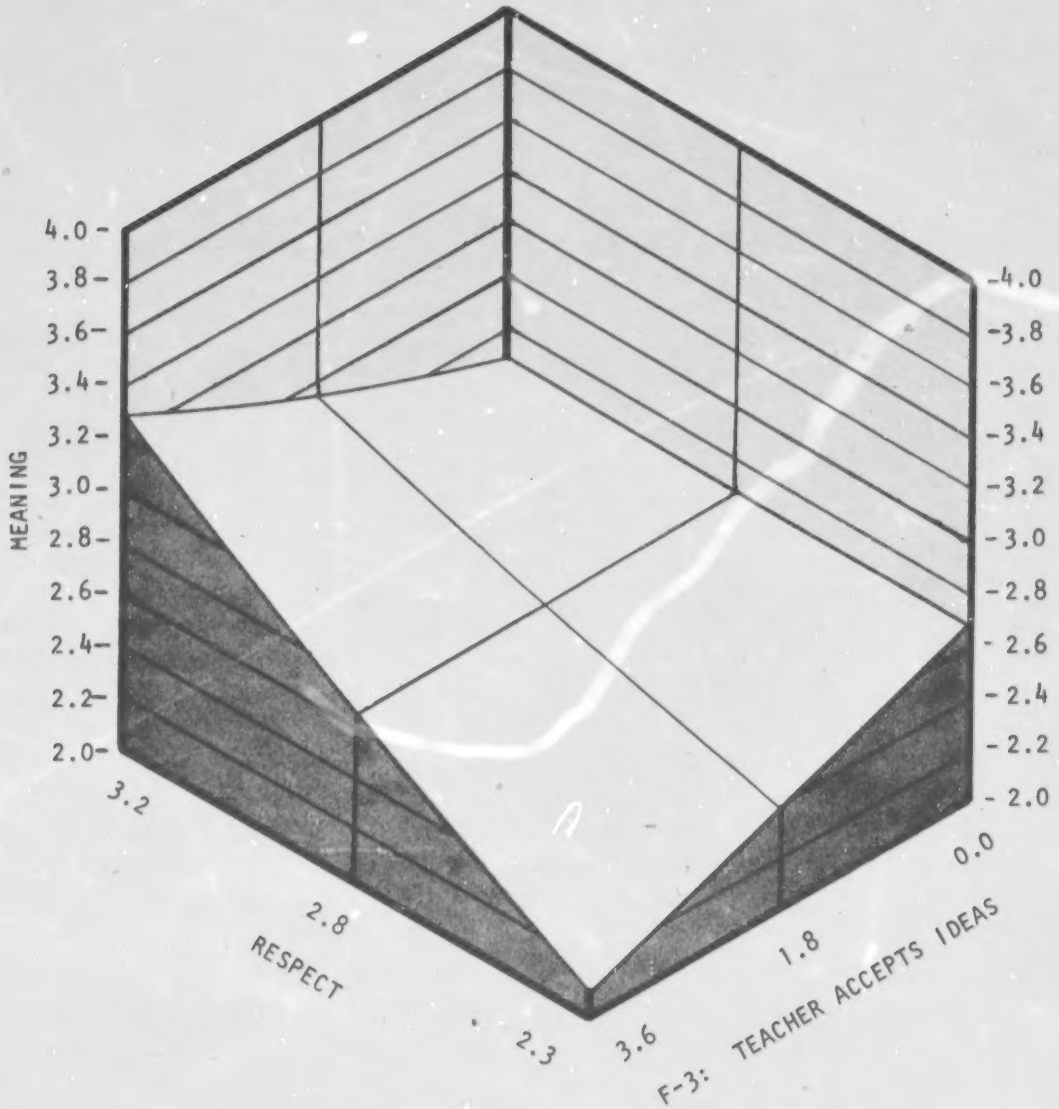
$R^2 = 0.85844$ $s_E = 0.077$ $\underline{F} = 391.142$



MEANING (SEC.)

$M = 2.679985 - 0.98054F3 + 0.3508F3R$

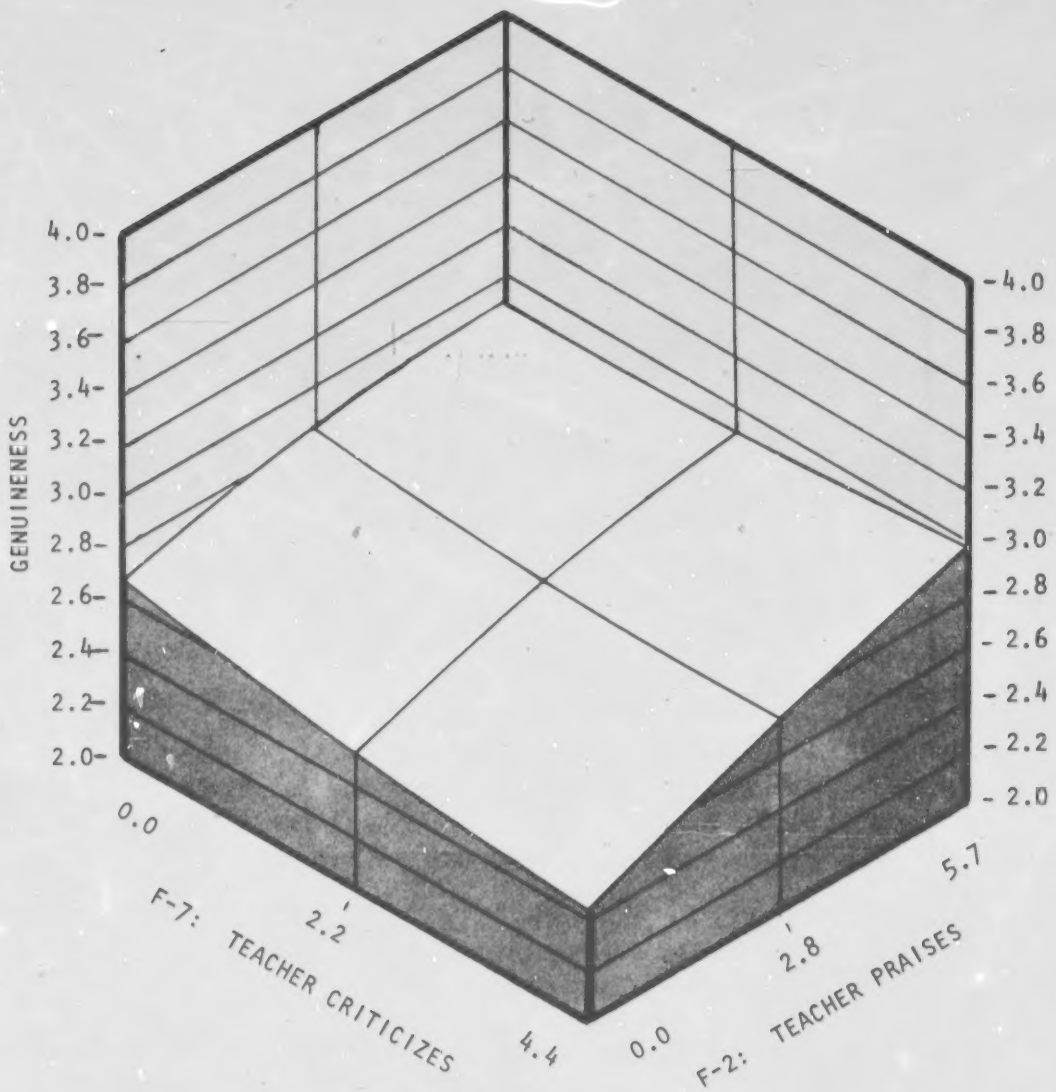
$R^2 = 0.335$ $s_E = 0.179$ $\underline{F} = 24.003$



GENUINENESS (ELEM.)

$$G = 2.66913 + 0.0775F2 - 0.0855F7 - 0.0060F2F2 + 0.0129F2F7 + 0.0065F7F7$$

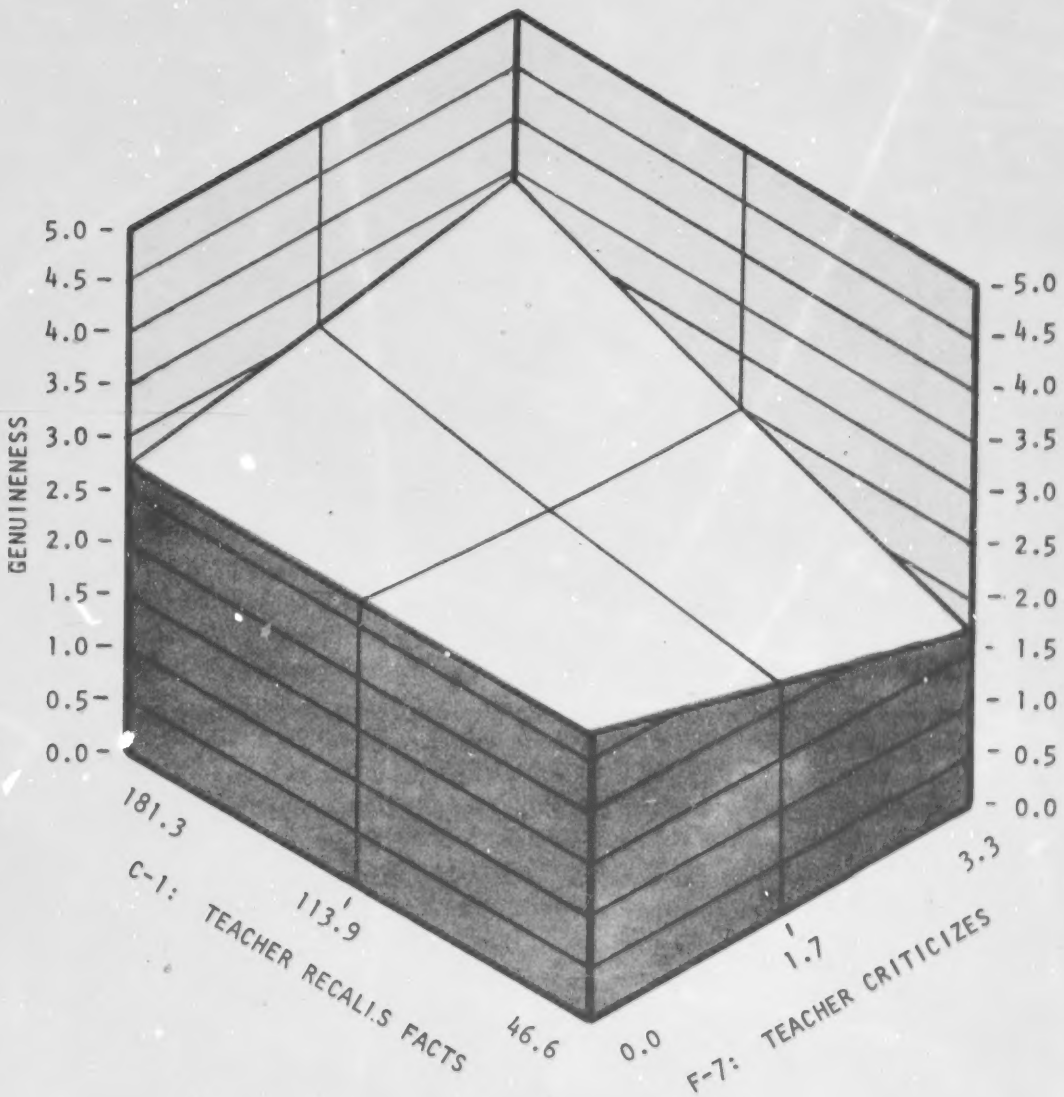
$R^2 = 0.219$ $S_E = 0.198$ $\underline{F} = 8.746$



GENUINENESS (SEC.)

$G = 2.74019 - 0.4926C7 + 0.0038F7C1$

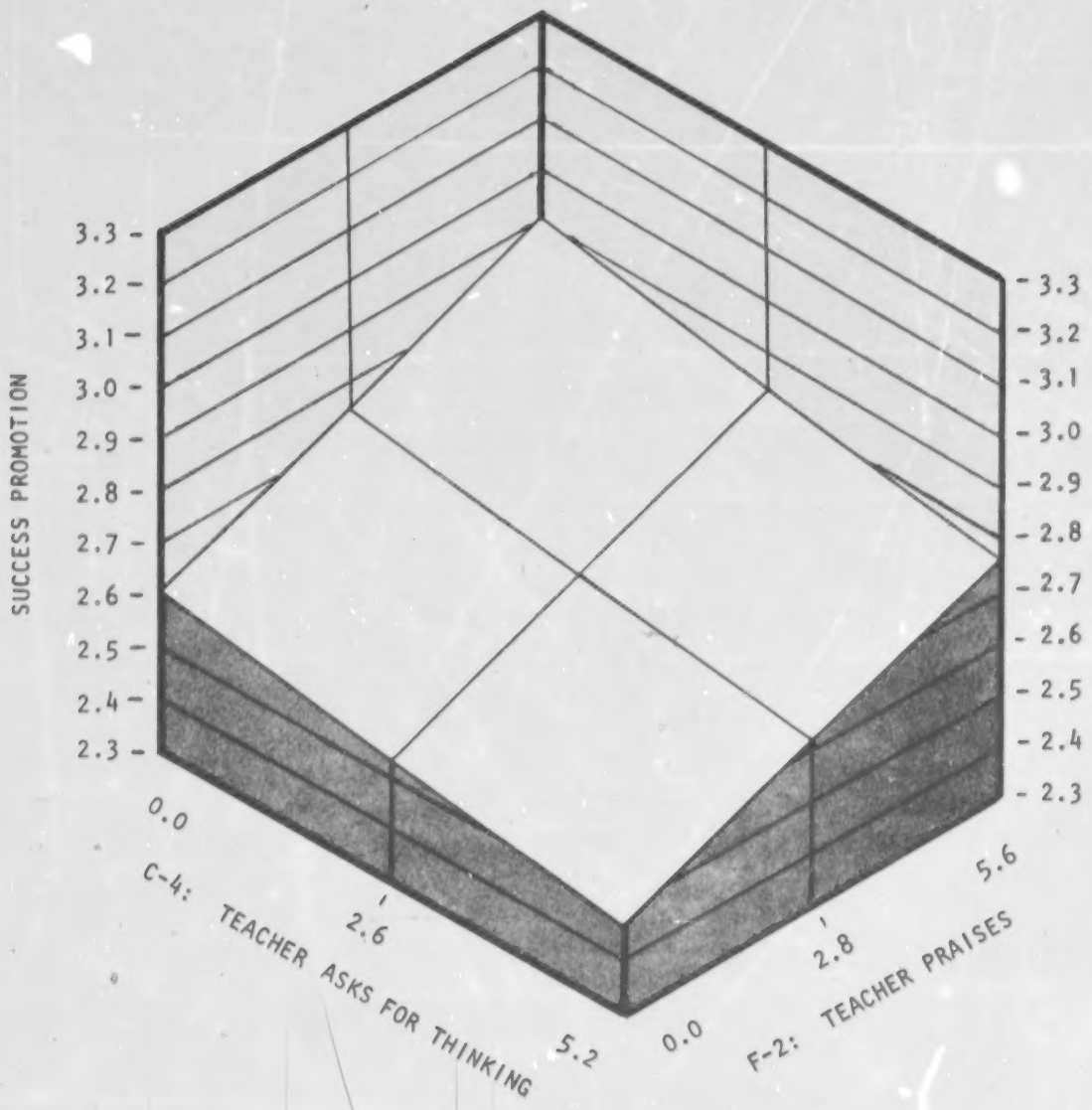
$R^2 = 0.231$ $S_E = 0.197$ $F = 14.281$



SUCCESS PROMOTION (ELEM.)

$SP = 2.61178 + 0.0528F2 + 0.0278C4$

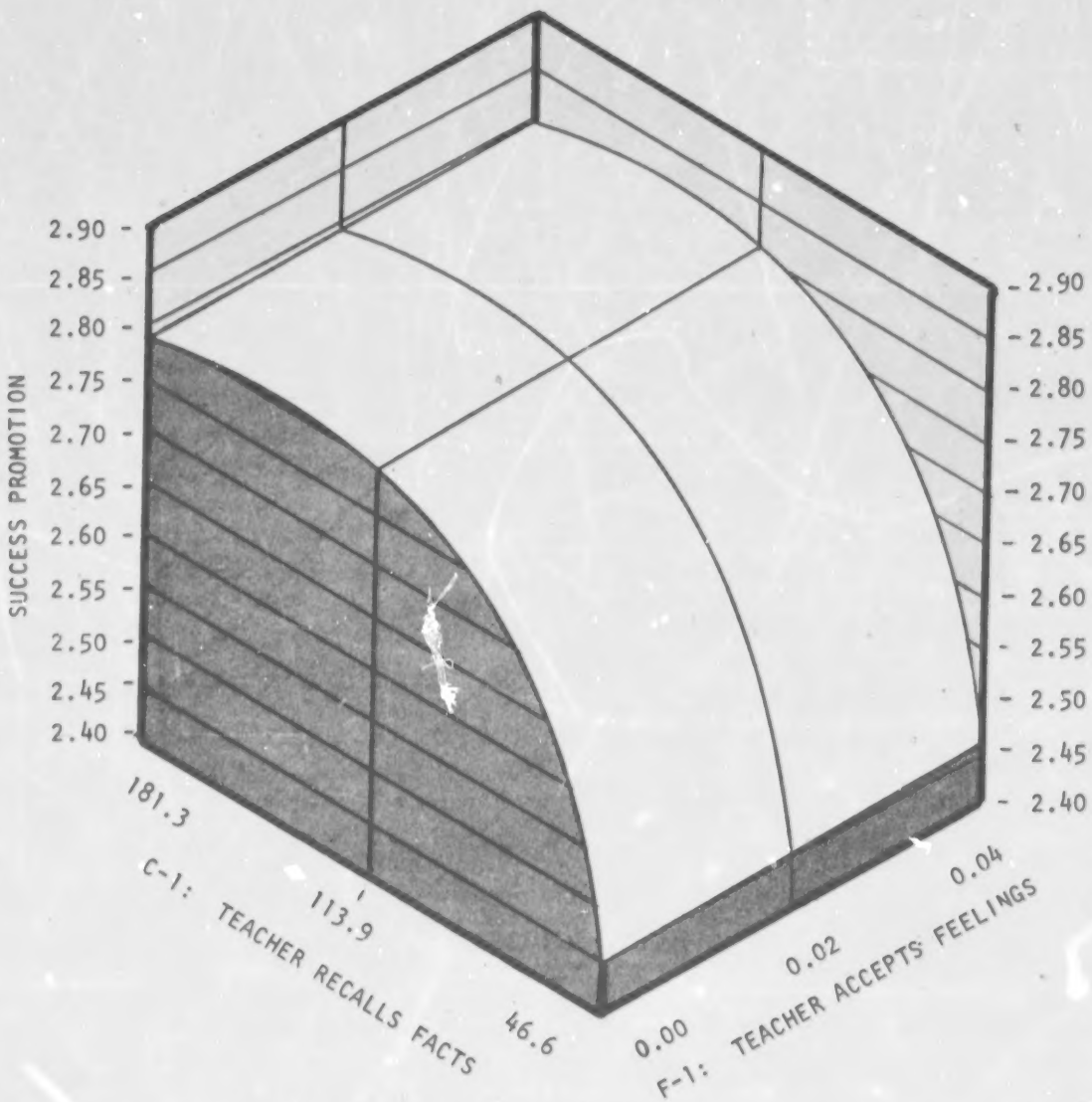
$R^2 = 0.230$ $\quad s_E = 0.203$ $\quad \underline{F} = 23.783$



SUCCESS PROMOTION (SEC.)

$SP = 1.99533 + 0.2985F1 + 0.0116C1 - 0.00004C1C1$

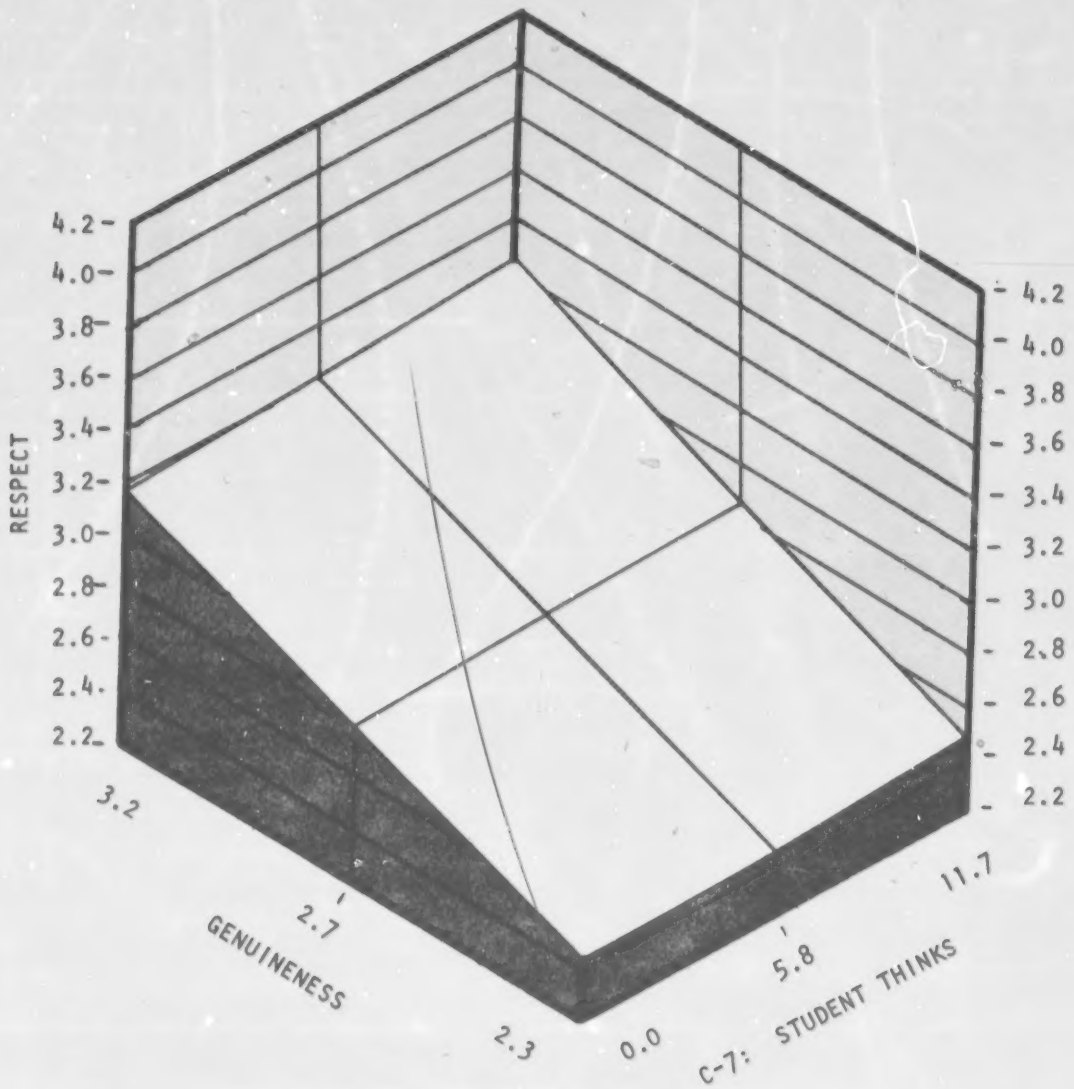
$R^2 = 0.347$ $S_E = 0.206$ $F = 10.281$



RESPECT (ELEM.)

$$R = .473221 + \underset{1.94557}{0.8459G} + \underset{0.05382}{0.0020C7G}$$

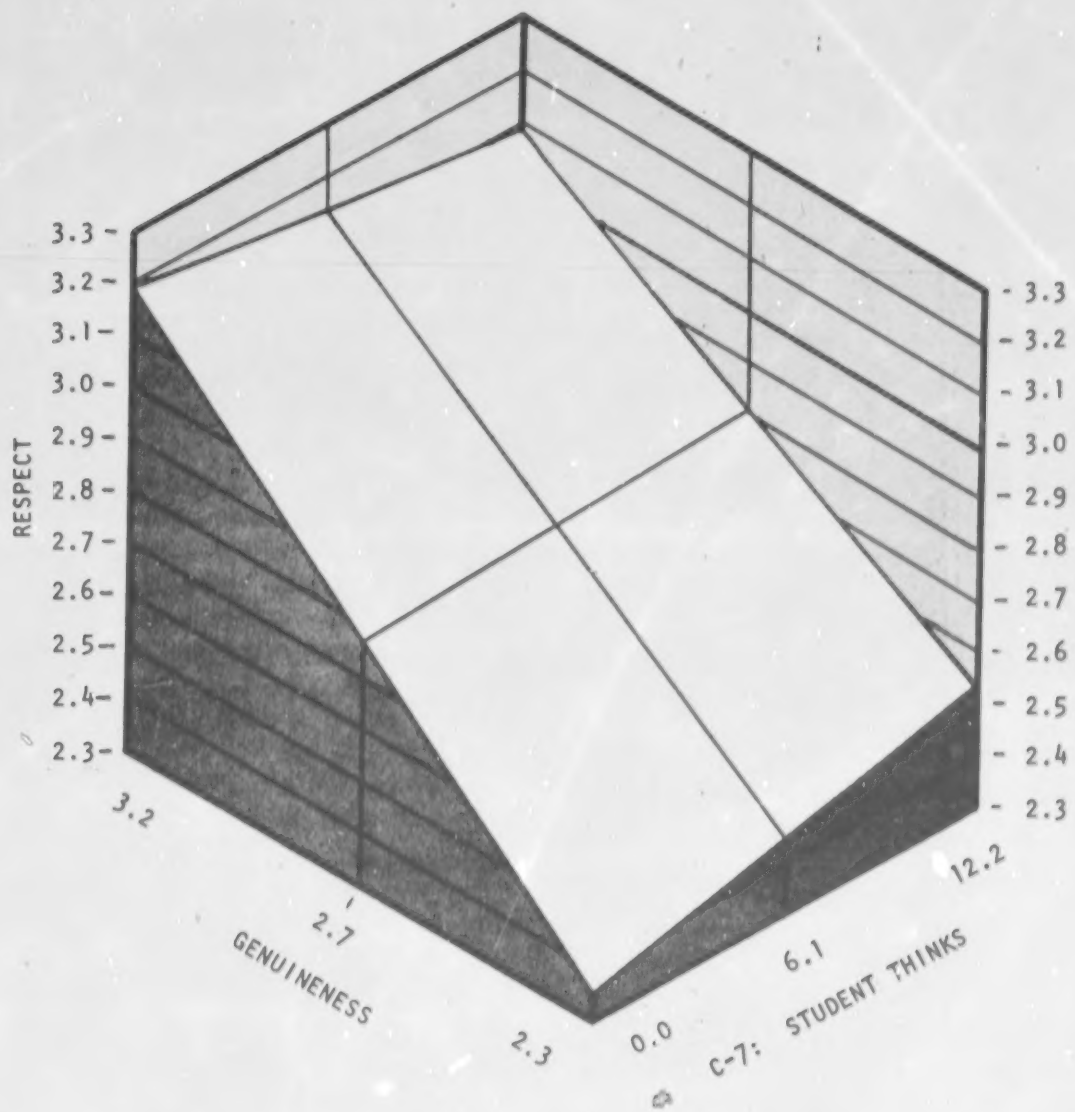
$R^2 = 0.777$ $\quad S_E = 0.105$ $\quad \underline{F} = 278.558$



RESPECT (SEC.)

$R = .18696 + .07956C7 + 0.9541G - 0.0281C7G$

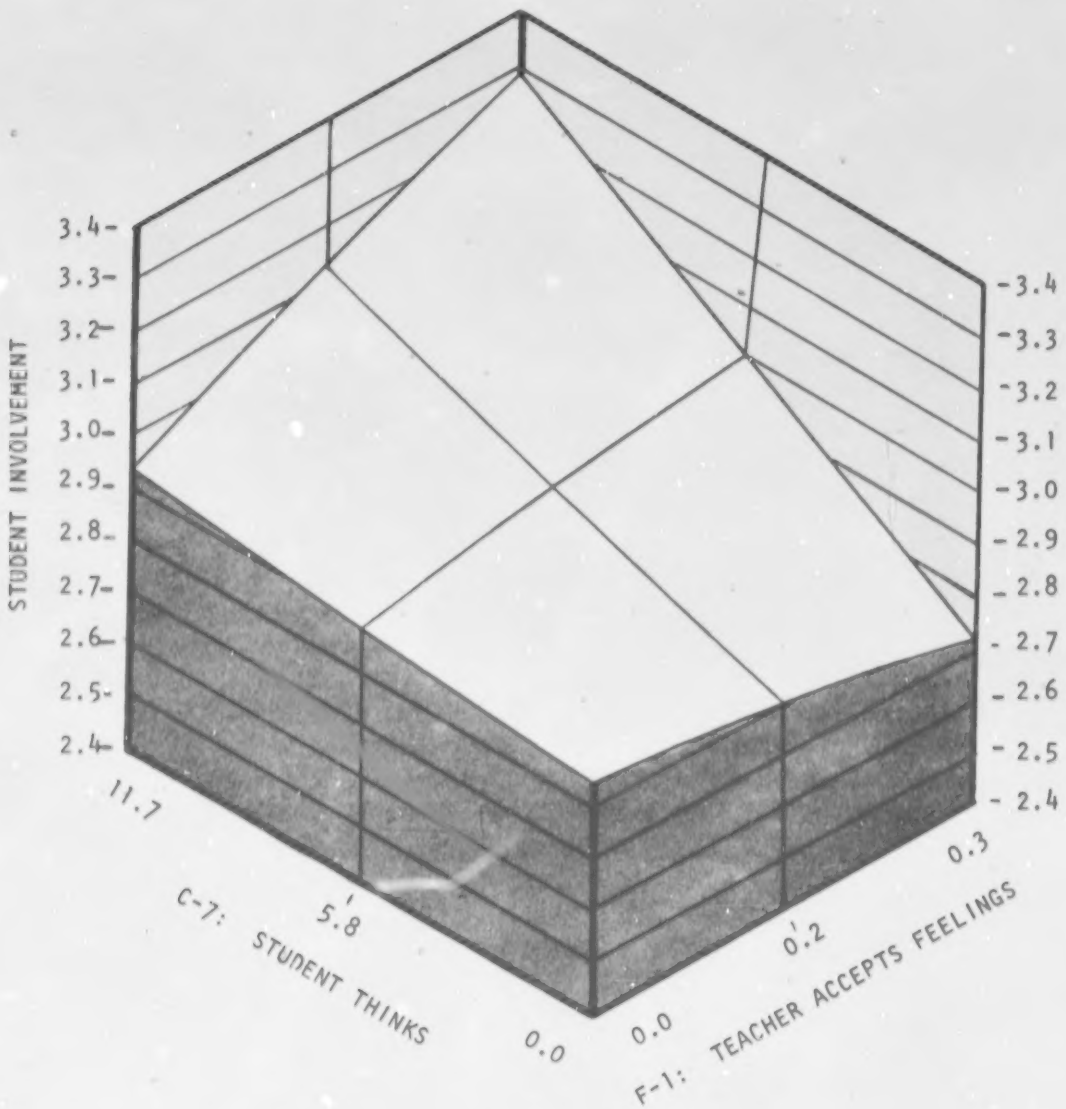
$R^2 = 0.802$ $S_E = 0.101$ $F = 127.578$



STUDENT INVOLVEMENT (ELEM.)

$SI = 2.84526 - 0.1893F1 + 0.0079C7 - 0.5217F1F1 + 0.1191F1C7$

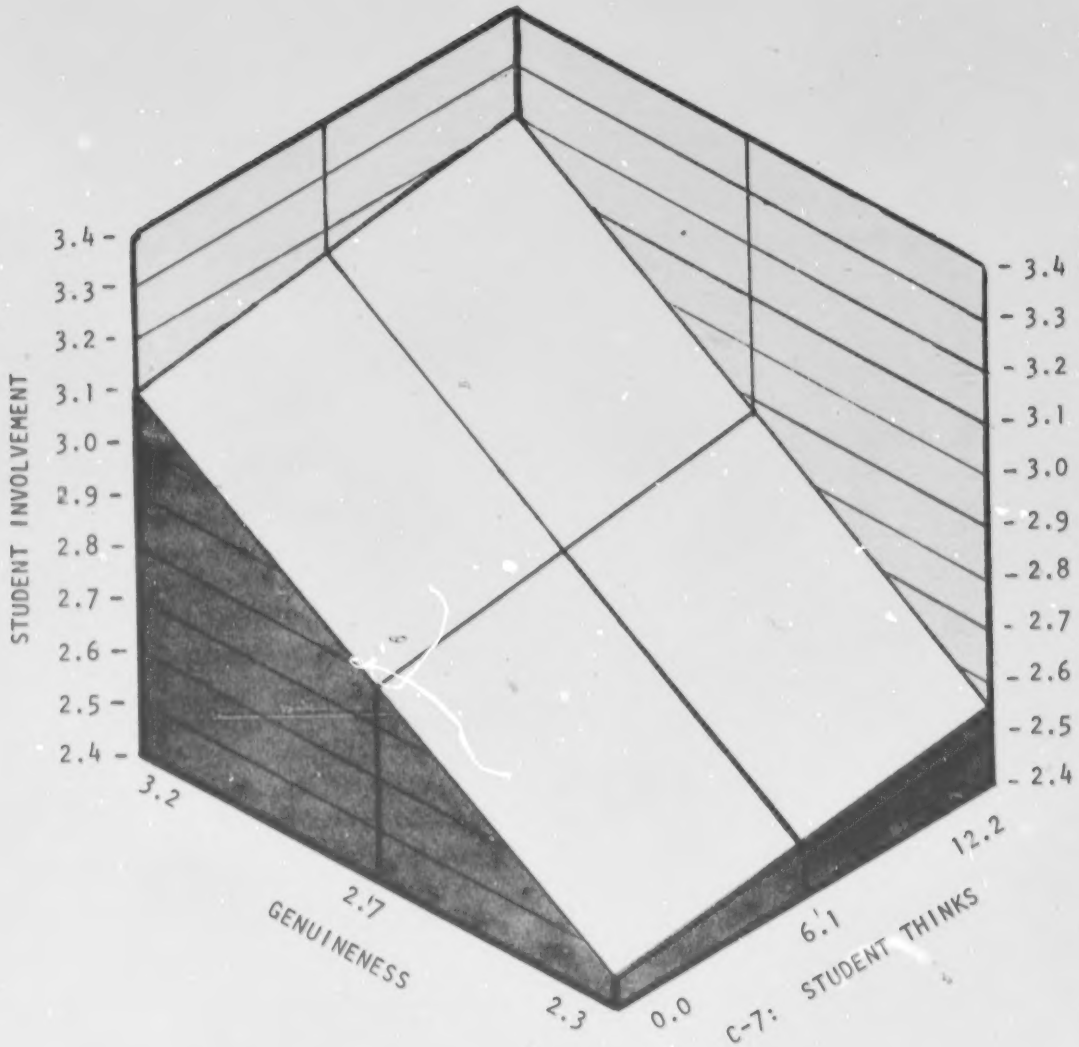
$R^2 = 0.193$ $S_E = 0.169$ $F = 9.388$



STUDENT INVOLVEMENT (SEC.)

$SI = .772447 + .00823C7 + 0.7408G$

$R^2 = 0.622$ $S_E = .135$ $F = 78.256$



APPENDIX B

SELECTED THREE-VARIABLE RESPONSE SURFACES

NOTES:

1. Notes 1-7 on p. 25 apply here, also.

2. The value of the variable which is held constant for the set of three figures is presented in the box under each figure.

F-1: TEACHER ACCEPTS FEELINGS (ELEM.)

$$F\text{-}1 = 0.01314 - 0.0072F9 + 0.0001F9F9 + 0.0003F9C7 + 0.001F9M - 0.0012C7C7 + 0.008C7M$$

$\underline{F} = 6.529$

$R^2 = 0.202$

$s_E = 0.124$

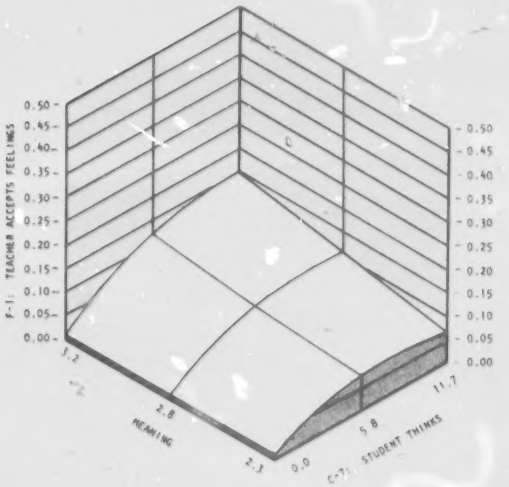


Fig. A: F-9 = 0.0

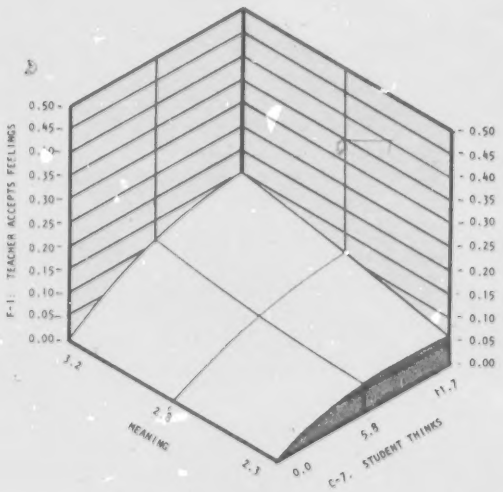


Fig. B: FL-9 = 10.6

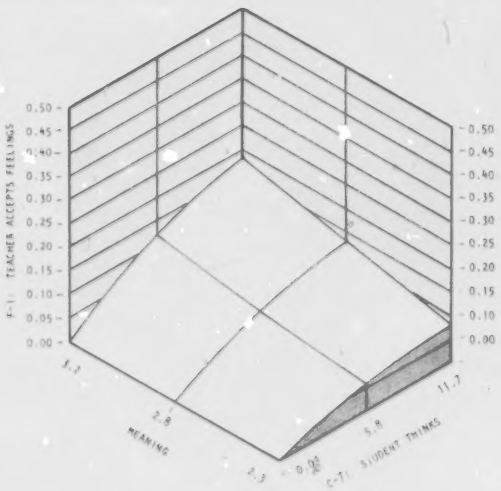


Fig. C: FL-9 = 21.1

F-1: TEACHER ACCEPTS FEELINGS (SEC.)

$$F\text{-}1 = 0.22262 - 0.284SI - 0.001C7C7 + 0.008C7M + 0.080MSI$$

$\underline{F} = 3.351$ $(p < .025)$

$R^2 = 0.126$

$s_E = 0.\ldots 0d$

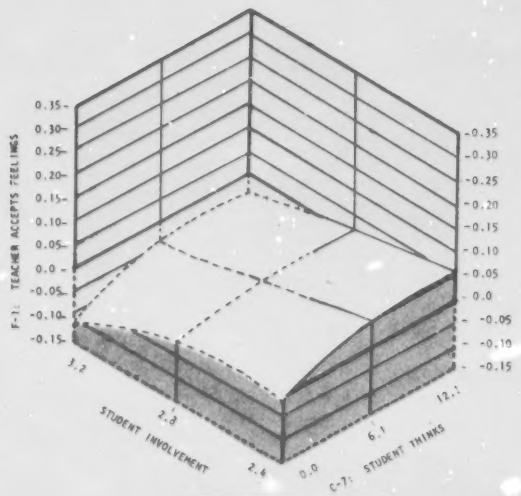


Fig. A: M=2.3

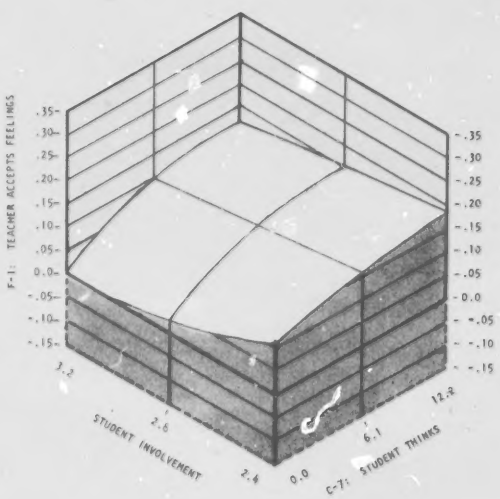


Fig. B: M=2.7

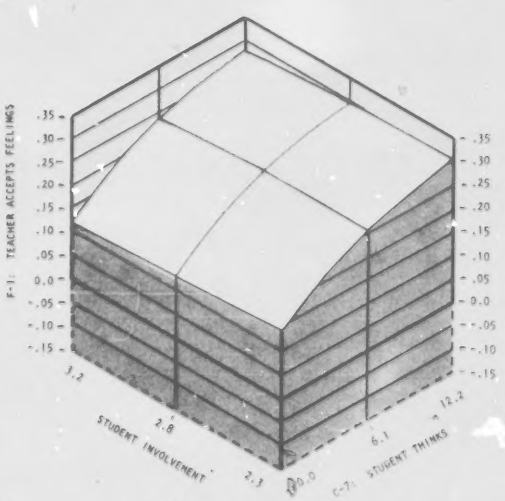


Fig. C: M=3.1

F-2: TEACHER PRAISES (ELEM.) (02)

$$F\text{-}2 = -4.20812 - 0.9548C2 - 45.003M + 49.205S1$$

$\underline{F} = 13.634$

$R^2 = 0.396$

$s_E = 1.809$

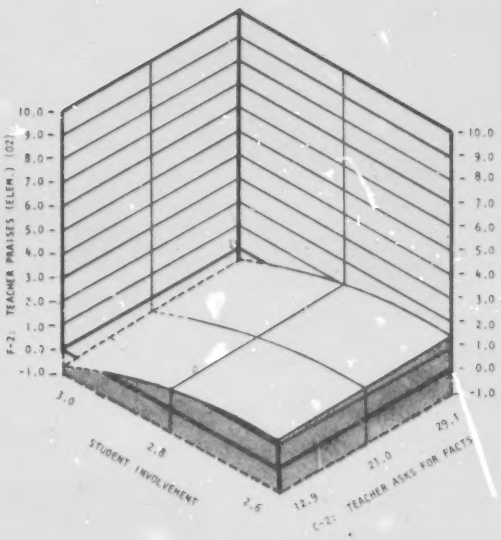


Fig. A: M=2.4

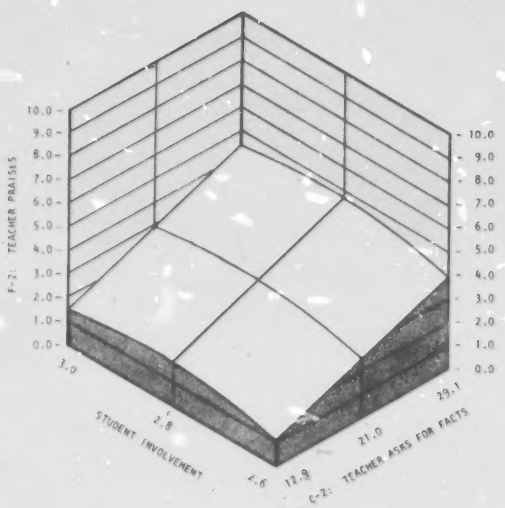


Fig. C: M=2.8

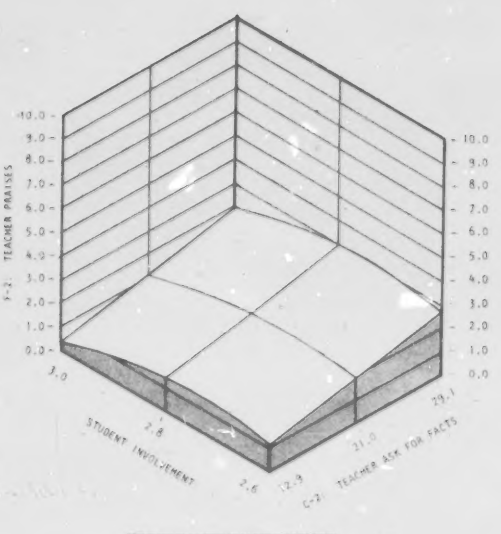


Fig. B: M=2.6

F-2: TEACHER PRAISES (SEC.)

$$F\text{-}2 = -0.87475 + 0.0520C5 - 0.7402C7 - 0.0171C5SI - 0.0020C7C7 + 0.2660C7SI + 0.016SISI$$

$\underline{F} = 2.026$ ($p < .25$)

$R^2 = 0.118$

$s_E = 0.749$

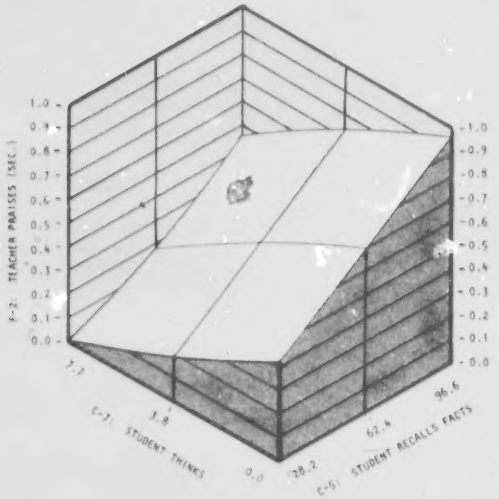


Fig. A: SI = 2.6

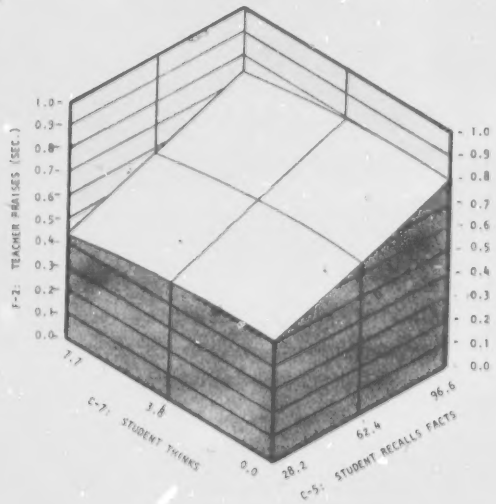


Fig. B: SI = 2.8

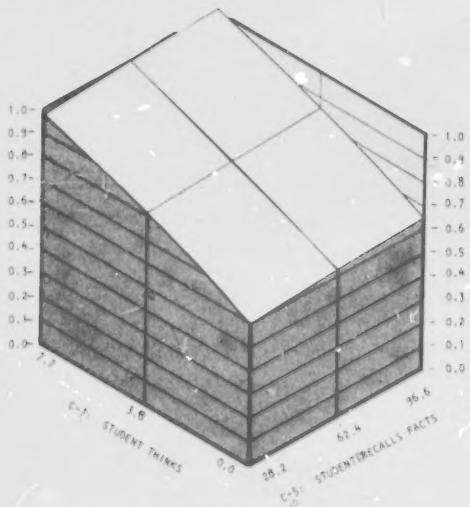


Fig. C: SI = 3.0

F-3: TEACHER ACCEPTS IDEAS (ELEM.)

$$F\text{-}3 = 6.42004 - 0.1878C2 - 0.3732C7 - 2.631SI - 0.0011C2C2 - 0.0063C2C7 + 0.1111C2SI + 0.185C7SI$$

$\underline{F} = 7.963$

$R^2 = 0.266$

$s_E = 1.128$

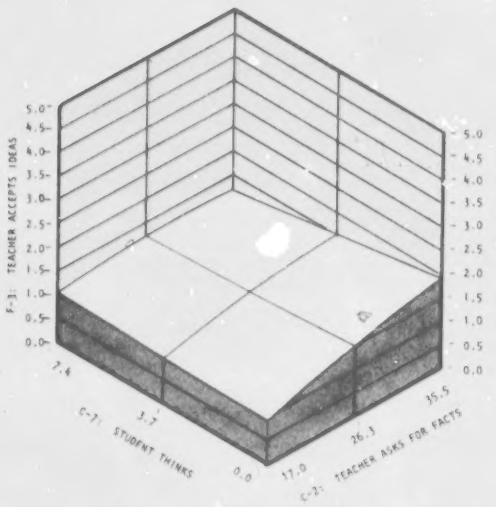


Fig. A: SI = 2.7

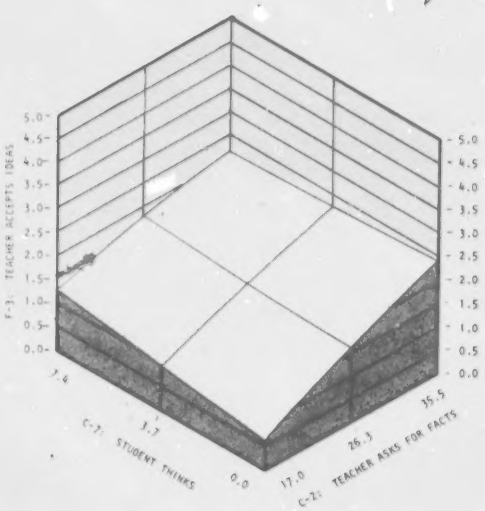


Fig. C: SI = 3.1

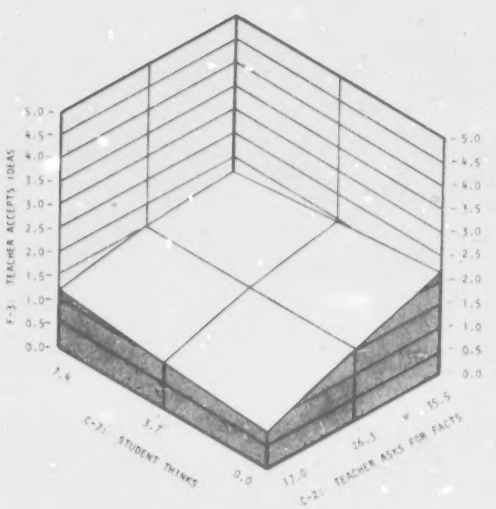


Fig. B: SI = 2.9

F-3: TEACHER ACCEPTS IDEAS (SEC.)

$$F\text{-}3 = 1.83656 - 0.2616C2 - 0.5820M + 0.0069C2C4$$

$\underline{F} = 9.003$

$R^2 = 0.373$

$s_E = 1.017$

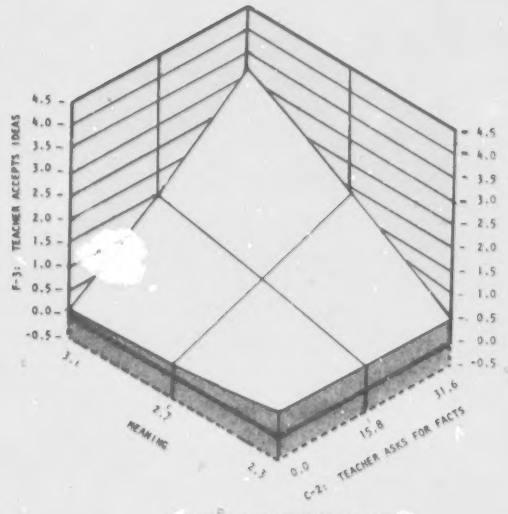


Fig. A: C-4=0.0

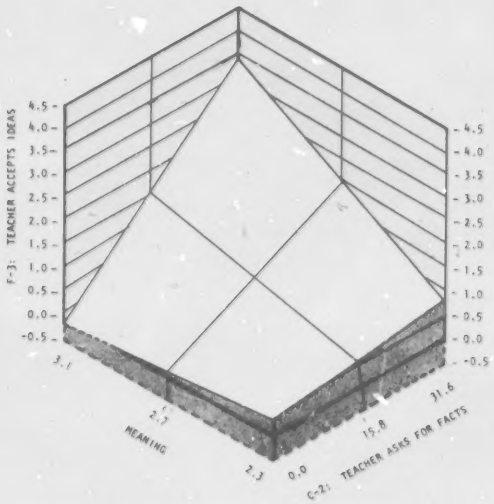


Fig. B: C-4=2.2

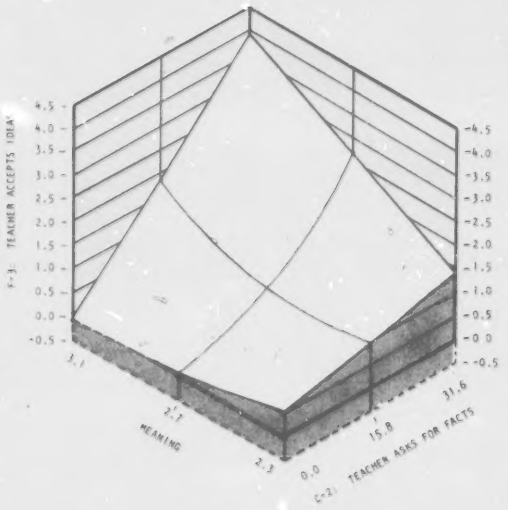


Fig. C: C-4=4.4

F-8: STUDENT RESPONDS (ELEM.) (02)

F-8 = 96.86507 - 0.2505F7R - 0.354C2R

$\underline{F}$ = 15.954

R^2 = 0.198

^2_E = 24.513

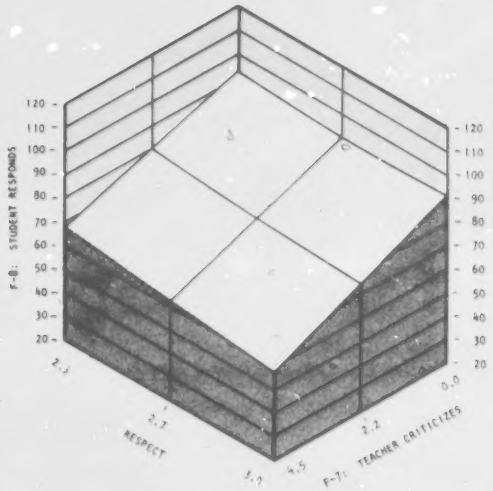


Fig. A: C-2 = 4.8

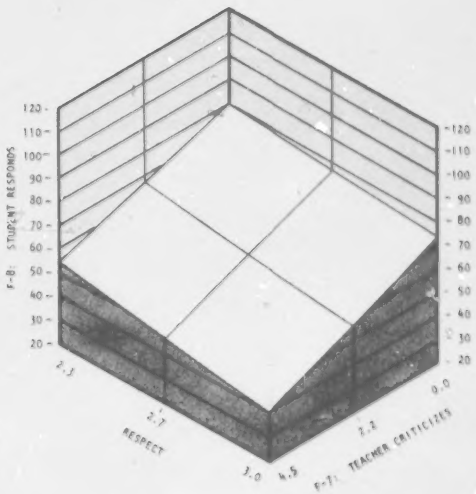


Fig. B: C-2 = 21.0

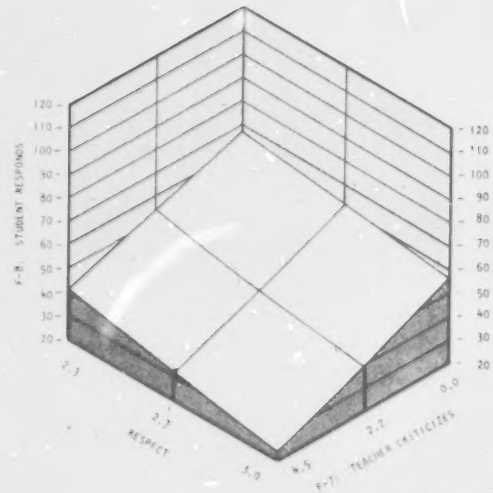


Fig. C: C-2 = 37.2

F-8: STUDENT RESPONDS (SEC.)

$$F\text{-}8 = -206.33032 + 86.0583F2 - 7.9403C3 + 193.9461R - 2.1567F2C3 - 28.1180F2R - 35.4700RR$$

$\underline{F} = 3.039 \ (p < .05)$

$R^2 = 0.167$

$s_E = 33.869$

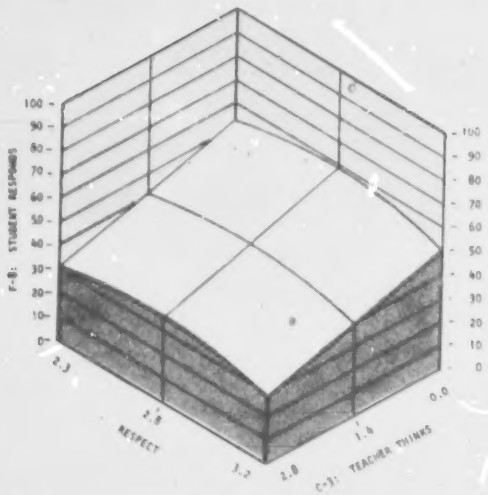


Fig. A: F-2 = 0.0

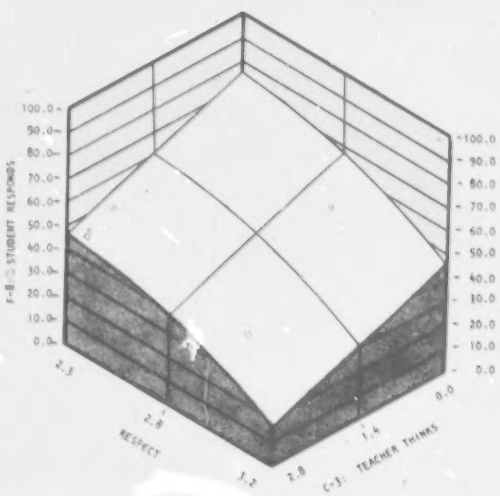


Fig. B: F-2 = 1.1

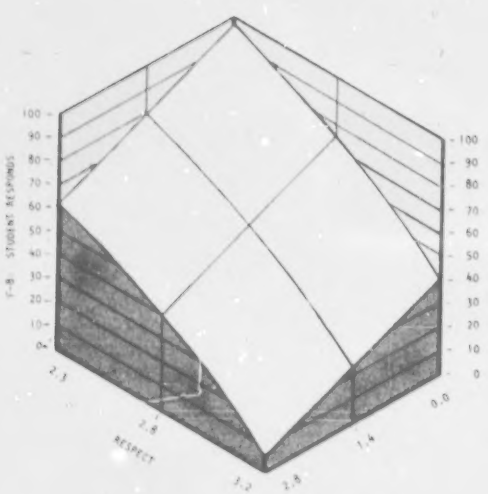


Fig. C: F-2 = 2.2

F-9: STUDENT INITIATES (ELEM.) (02)

$$F\text{-}9 = 3.10257 - 0.2938C2 - 13.1610MM + 16.7000SPSP$$

$\underline{F} = 15.518$

$R^2 = 0.267$

$s_E = 12.329$

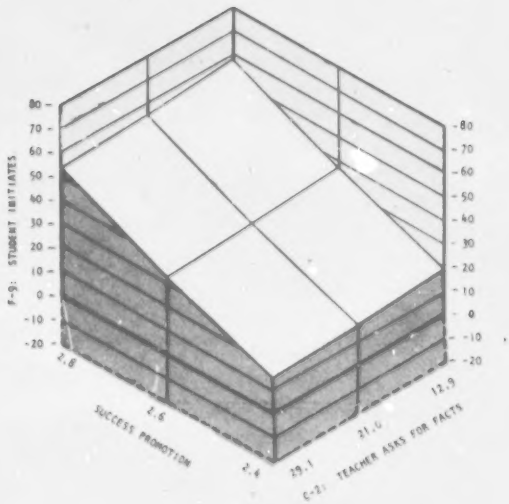


Fig. A: M=2.4

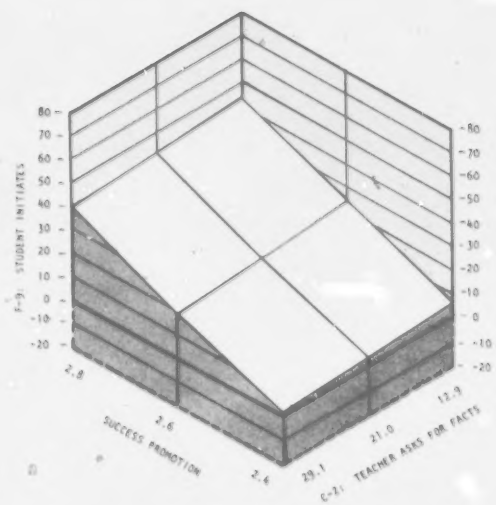


Fig. B: M=2.6

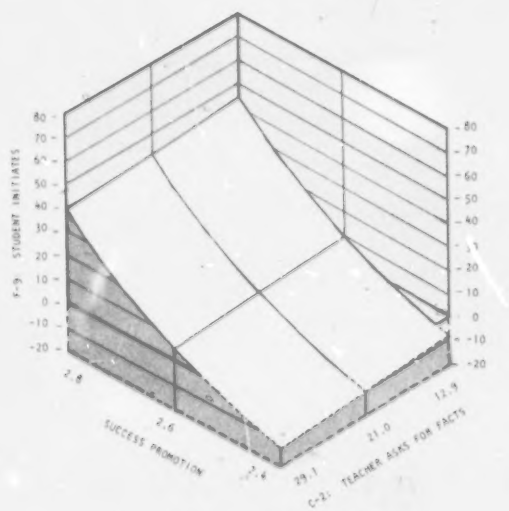


Fig. C: M=2.8

F-9: STUDENT INITIATES (SEC.)

$$F\text{-}9 = 89.53214 - 8.4755F2 + 2.0183C2 - 82.1990SP + 0.8347F2F2 + 0.3014F2C2 + 0.0123C2C2 - 1.1191C2SP + 21.6000SPSP$$

$\underline{F} = 4.568 \ (p < .01)$

$R^2 = 0.291$

$s_E = 9.092$

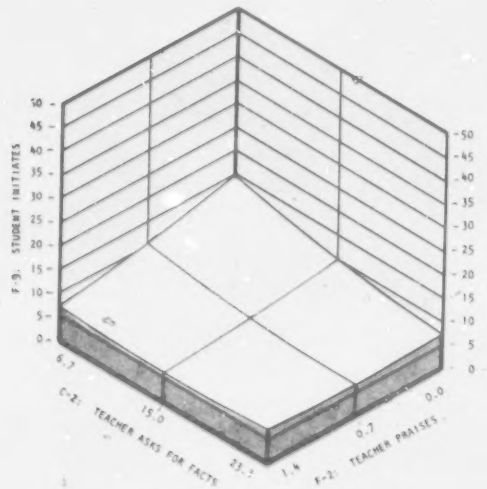


Fig. A: SP = 2.5

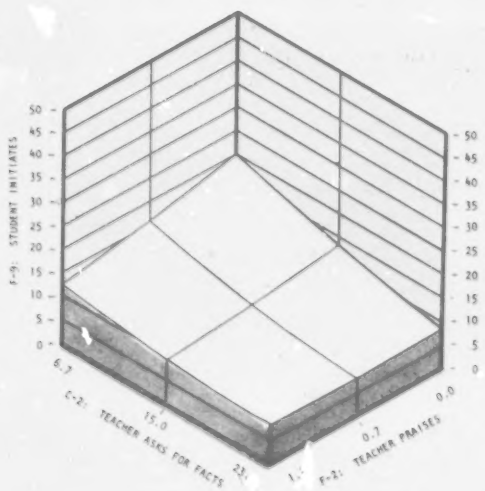


Fig. B: SP = 2.75

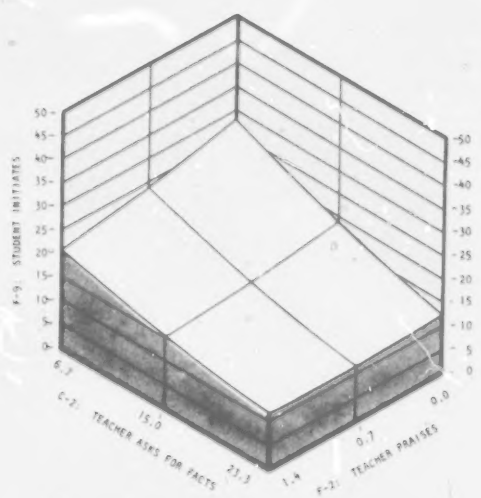


Fig. C: SP = 3.0

C-1: TEACHER RECALLS FACTS (ELEM.)

$$C\text{-}1 = -384.3706 - 33.435C8 + 172.711M + 166.987R - 1.611C8C8 + 44.496C8M - 31.155C8R - 60.680MR$$

$\underline{F} = 3.449$ $(p < .25)$

$R^2 = 0.136$

$s_E = 22.753$

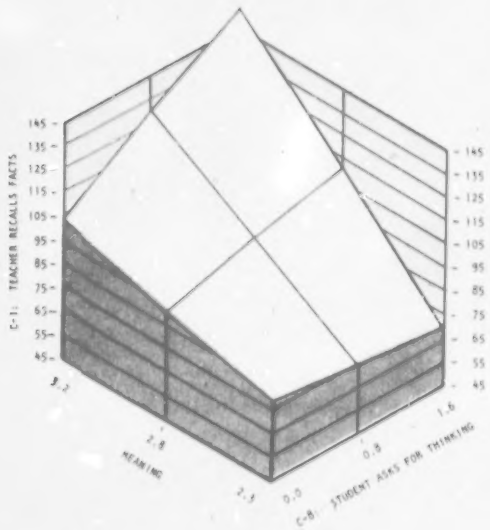


Fig. A: R = 2.4

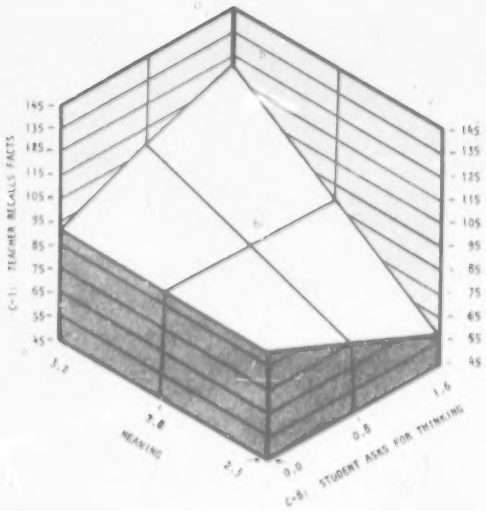


Fig. B: R = 2.8

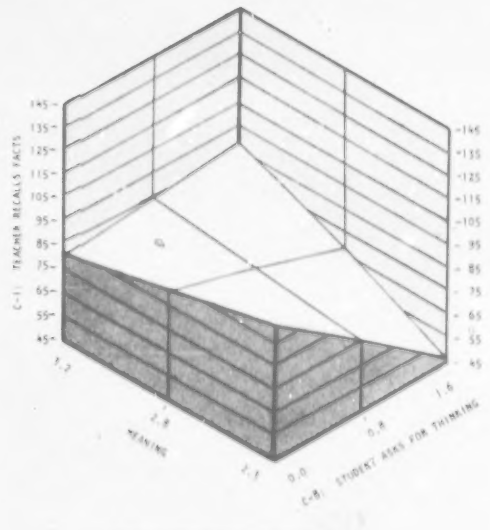


Fig. C: R = 3.3

C-1: TEACHER RECALLS FACTS (SEC.)

$$C\text{-}1 = 28.55307 + 13.124C6M - 13.505C6R + 11.84RR$$

$\underline{F} = 6.896$

$R^2 = 0.180$

$s_E = 30.97664$

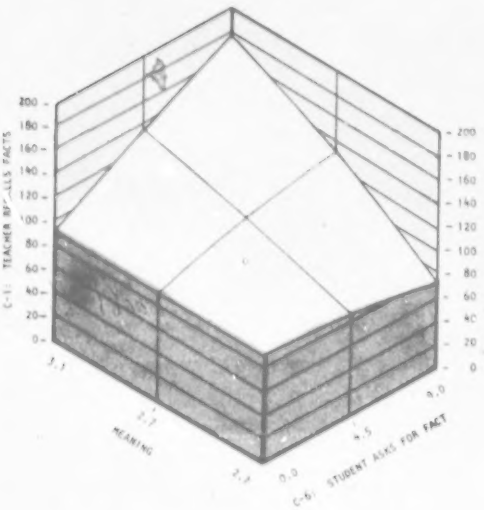


Fig. A: R = 2.3

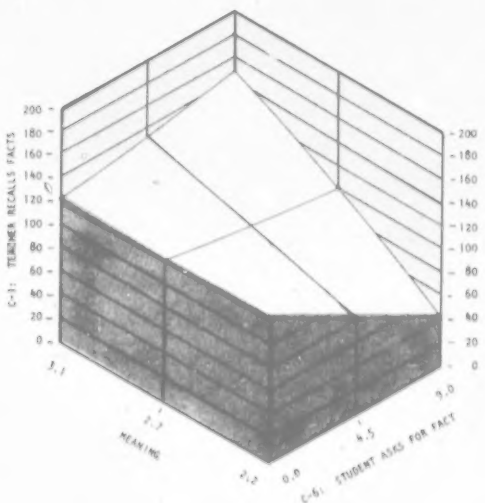


Fig. B: R = 2.8

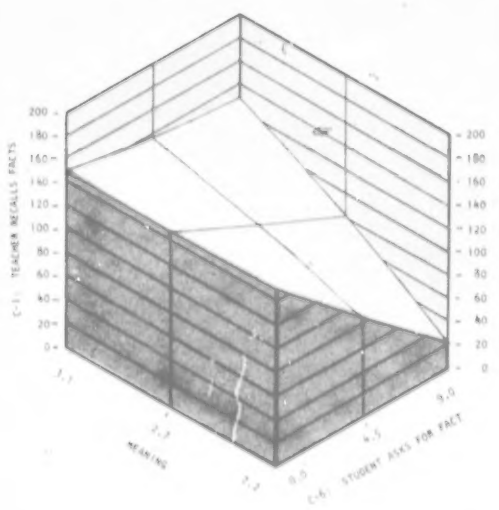


Fig. C: R = 3.2

C-2: TEACHER ASKS FOR FACTS (ELEM.)

$$C\text{-}2 = 5.95663 + 0.291F4M - 0.169C7M$$

$\underline{F} = 373.685$

$R^2 = 0.842$

$s_E = 3.899$

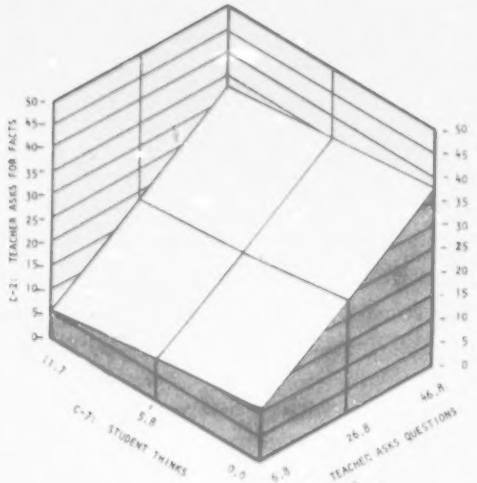


Fig. A: M = 2.3

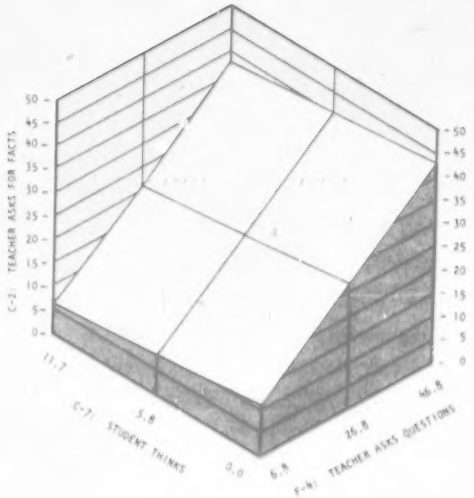


Fig. B: M = 2.7

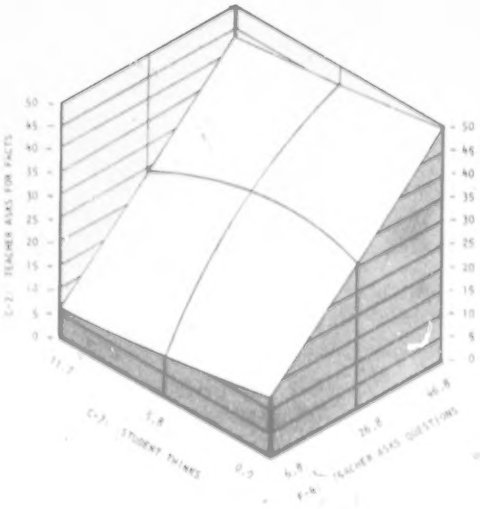


Fig. C: M = 3.2

C-2: TEACHER ASKS FOR FACTS (SEC.)

$$C\text{-}2 = 14.88066 + 0.876F4 + 1.9231C7 - 13.487R - 0.746C7R + 3.161RR$$

$\underline{F} = 129.357$

$R^2 = 3.011$

$s_E = 0.874$

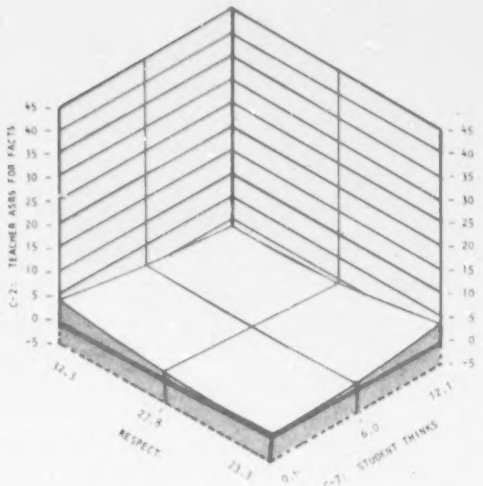


Fig. A: F-4 = 0.0

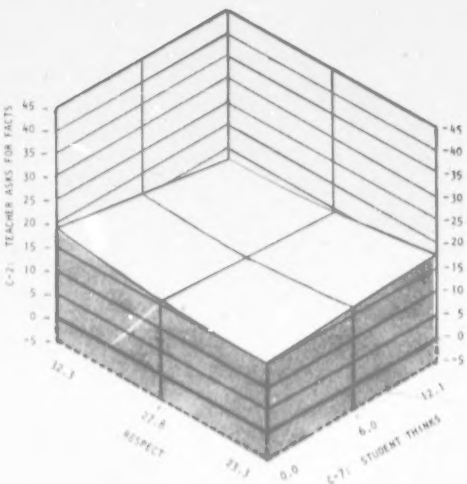


Fig. B: F-4 = 16.5

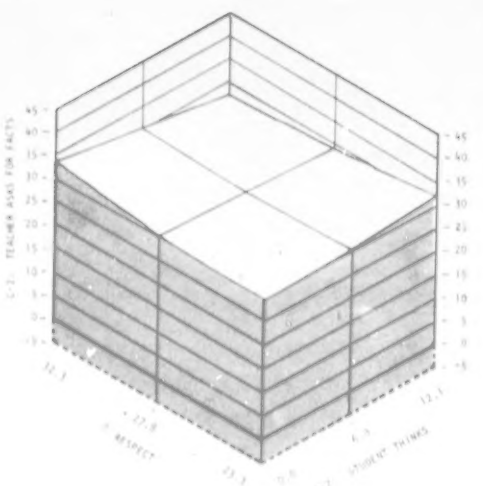


Fig. : F-4 =

C-3: TEACHER THINKS (ELEM.) (02)

$$C\text{-}3 = -\ 0.22865 + 0.0020F5G + 0.0610C8C8$$

$\underline{F} = 87.908$

$R^2 = 0.577$

$s_E = 0.363$

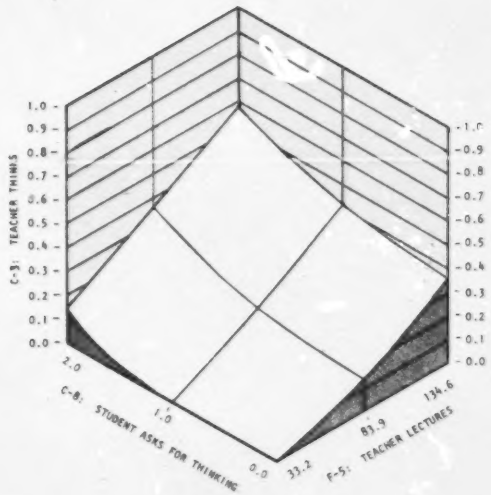


Fig. A: G = 2.2

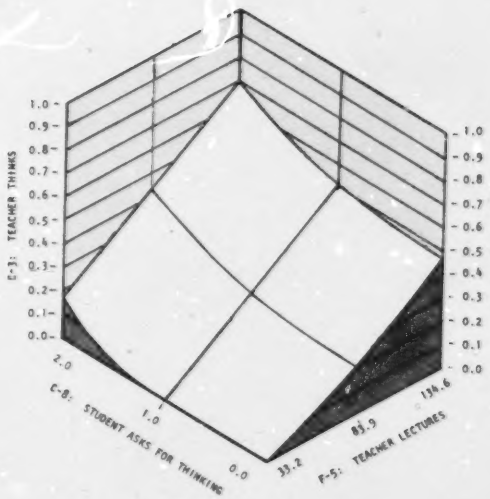


Fig. B: G = 2.6

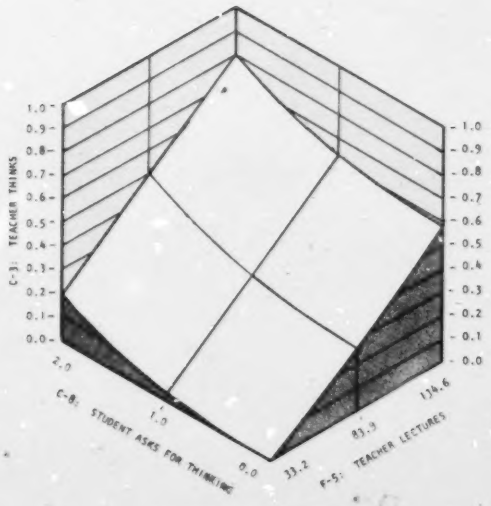


Fig. C: G = 3.0

C-3: TEACHER THINKS (SEC.)

$$C\text{-}3 = -10.88058 + 0.1319F5 + 3.9080G - 0.0063F5C8 - 0.0461F5G + 0.3250C8G$$

$\underline{F} = 3.324 \quad (p < .025)$

$R^2 = 0.153$

$s_E = 1.077$

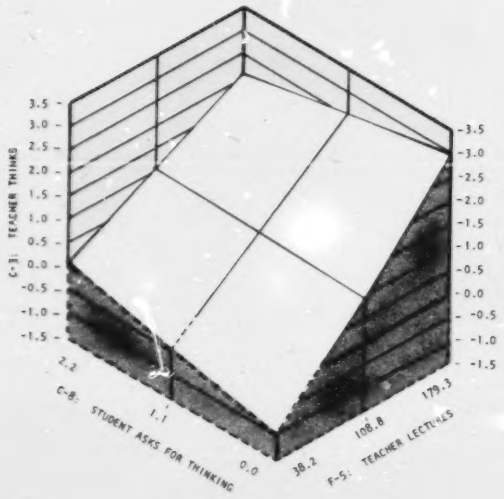


Fig. A: G=2.3

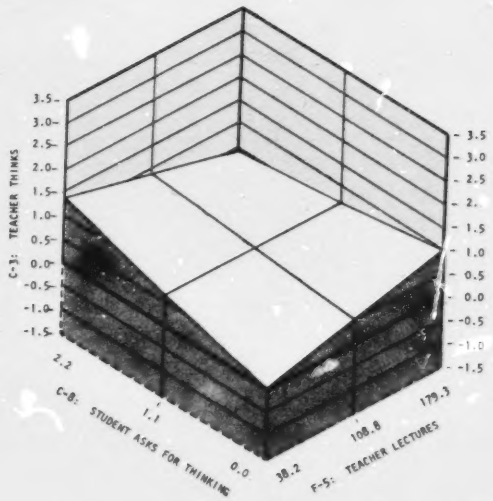


Fig. B: G=2.7

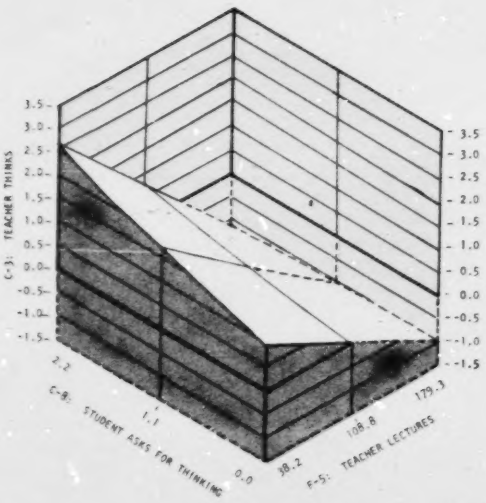


Fig. C: G=3.2

C-4: TEACHER ASKS FOR THINKING (ELEM.) (02)

$$C\text{-}4 = 1.57025 + 0.1675C7 - 0.0017F4F4 + 0.0162F4C7 + 0.0331F4M - 0.0205C7C7 - 0.3000MM$$

$\underline{F} = 56.690$

$R^2 = 0.731$

$s_E = 0.836$

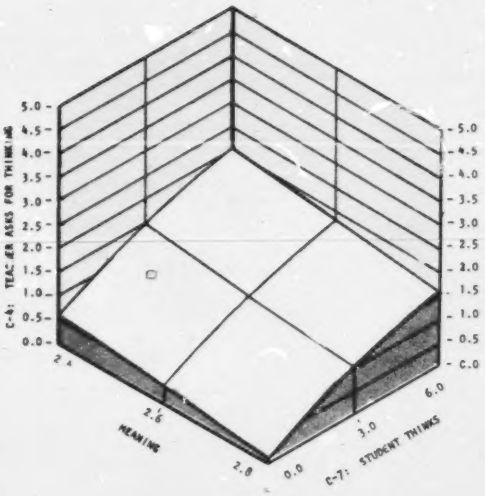


Fig. A: F-4 = 12.3

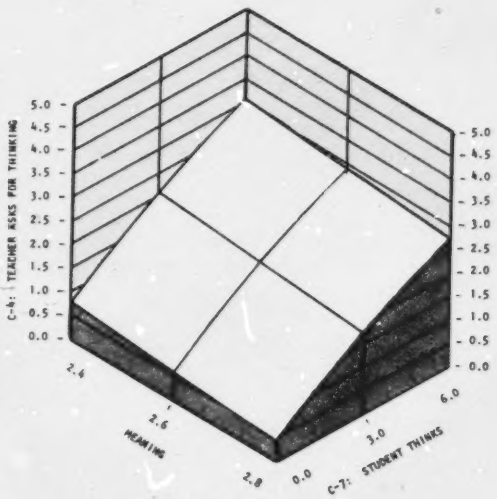


Fig. B: F-4 = 21.1

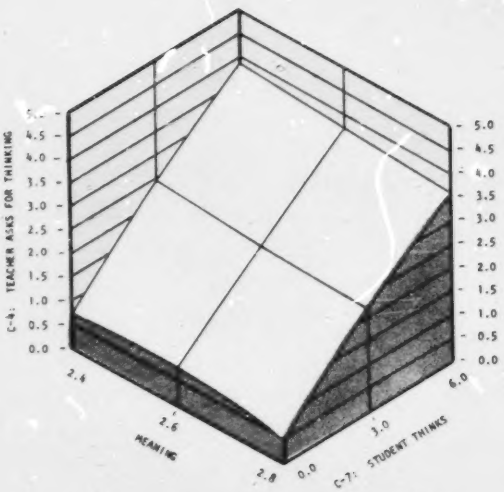


Fig. C: F-4 = 29.9

C-4: TEACHER ASKS FOR THINKING (SEC.)

$$C\text{-}4 = 0.19587 + 0.0127F3F4 + 0.0164F4C7 - 0.0074C7C7$$

$\underline{F} = 27.404$

$R^2 = 0.466$

$s_E = 1.256$

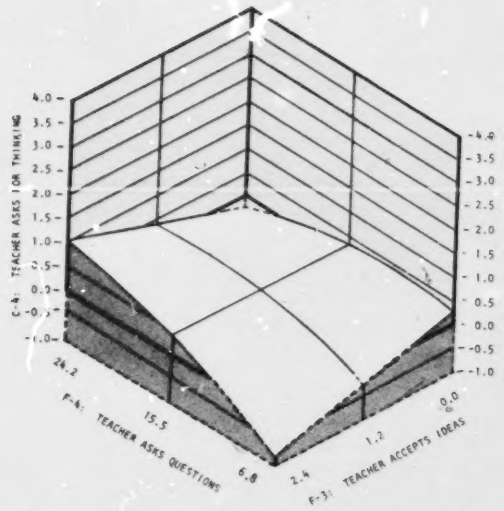


Fig. A: C-7=0.00

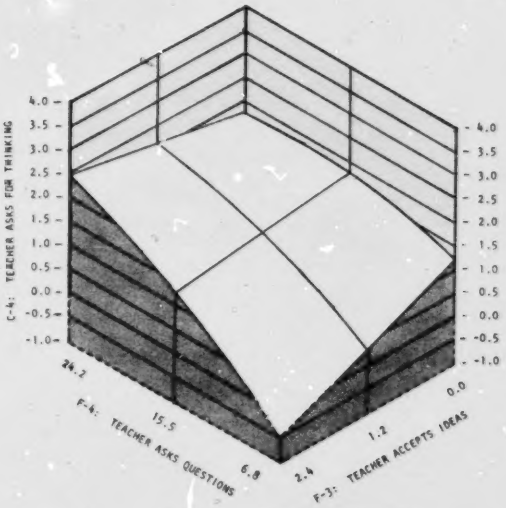


Fig. B: C-7=3.8

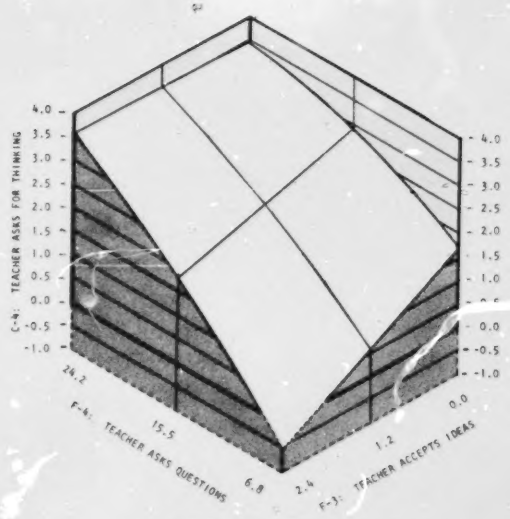


Fig. C: C-7=7.65

C-5: STUDENT RECALLS FACTS (ELEM.) (02)

C-5 = 123.62781 - 6.6238F7 - 0.4970F4R

$\underline{F}$ = 17.386

R^2 = 0.212

s_E = 28.021

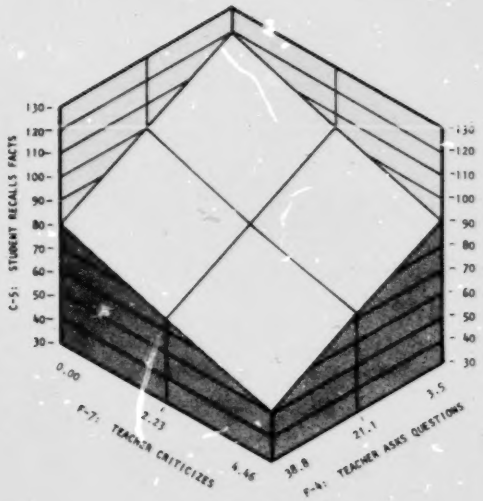


Fig. A: R = 2.3

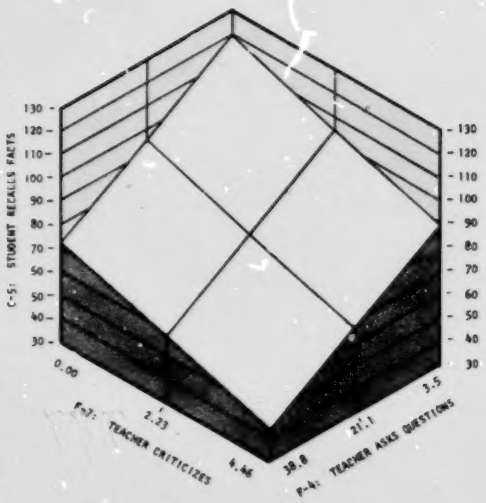


Fig. B: R = 2.7

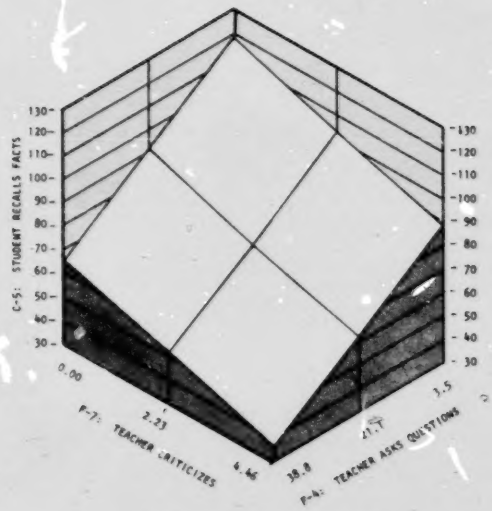


Fig. C: R = 3.1

C-5: STUDENT RECALLS FACTS (SEC.)

$$C\text{-}5 = -248.00826 + 248.6880R + 0.6719F7F7 - 3.472F7R - 0.0041C1C1 + 0.1000C1R - 45.0900R^2$$

$\underline{F} = 11.016$

$R^2 = 0.421$

$s_E = 26.913$

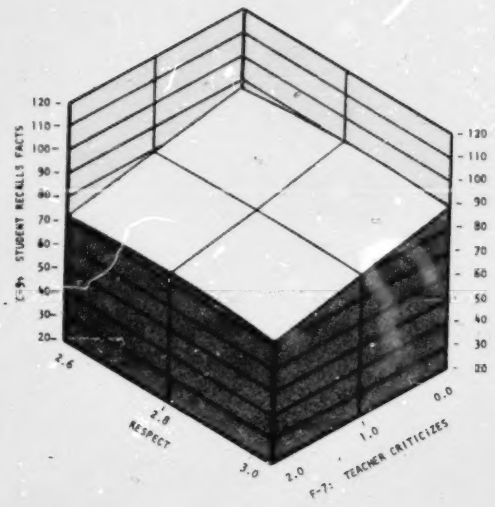


Fig. A: C-1 = 80.2

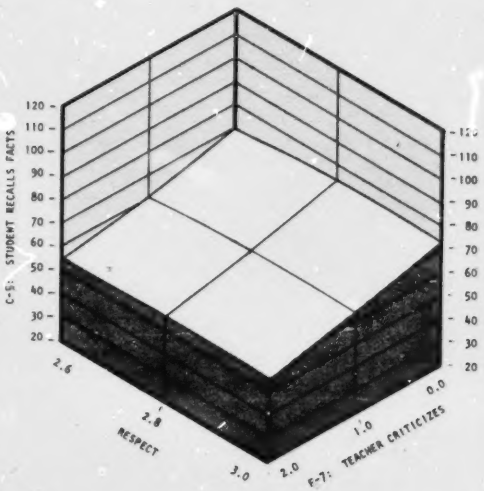


Fig. B: C-1 = 113.9

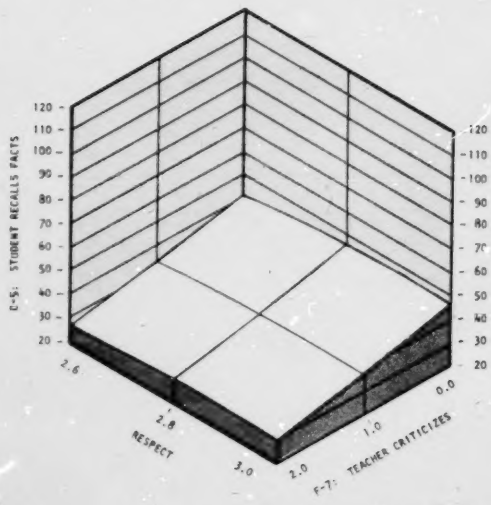


Fig. C: C-1 = 147.6

C-6: STUDENT ASKS FOR FACTS (ELEM.)

$$C\text{-}6 = 0.37854 - 0.013F4SI - 0.003F8SI + 0.280SISI$$

$\underline{F} = 6.182$

$R^2 = 0.105$

$s_E = 1.108$

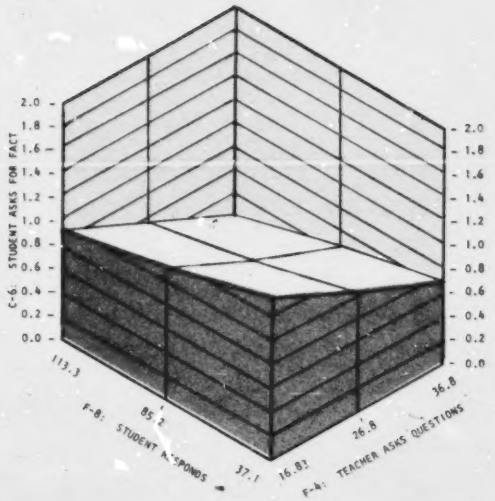


Fig. A: SI= 2.7

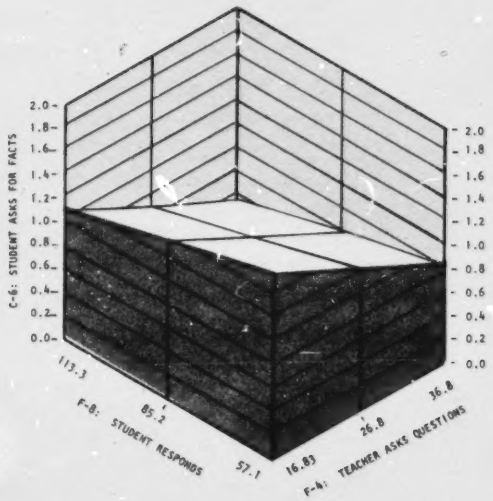


Fig. B: SI-2.9

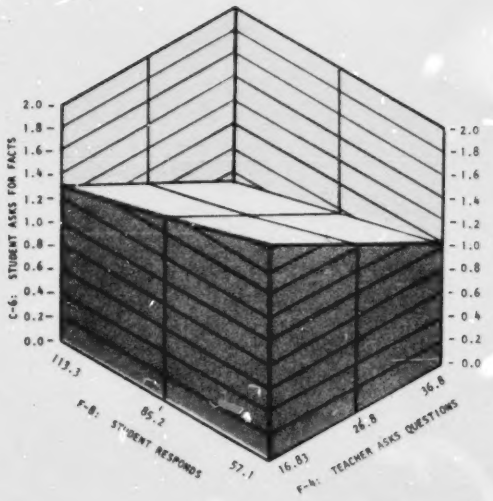


Fig. C: SI=3.1

C-6: STUDENT ASKS FOR FACT (SEC.)

$$C\text{-}6 = -0.46877 - 12.1825F3 + 0.2586F8 + 0.0105F3F8 + 3.9790F3S1 + 0.0002F8F8 - 0.6161F8S1 + 0.8700S1S1$$

$\underline{F} = 3.742$ ($p < .025$)

$R^2 = 0.225$

$s_e = 2.626$

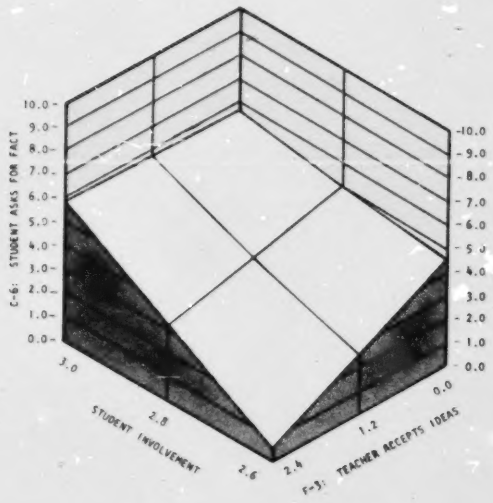


Fig. A: F-8 = 20.8

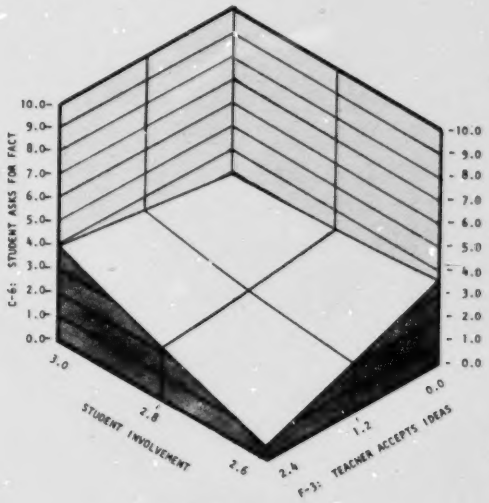


Fig. B: F-8 = 56.7

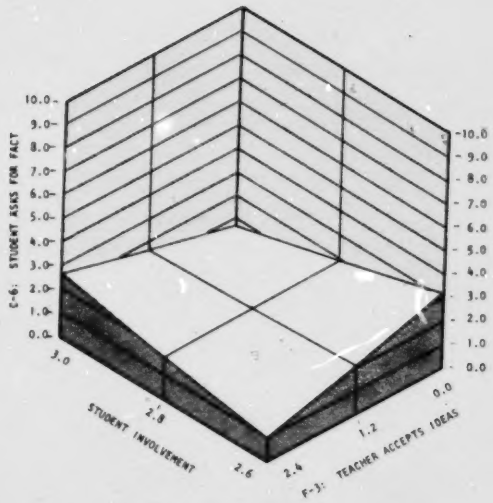


Fig. C: F-8 = 92.7

C-7: STUDENT THINKS (ELEM.) (02)

$$C\text{-}7 = 0.34793 - 4.7935C4 - 0.4520F3C4 + 2.4581C4SP$$

$\underline{F} = 68.044$

$R^2 = 0.615$

$s_E = 2.106$

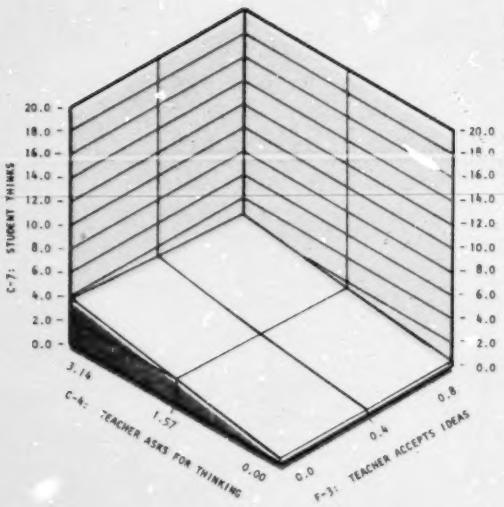


Fig. A: SP = 2.4

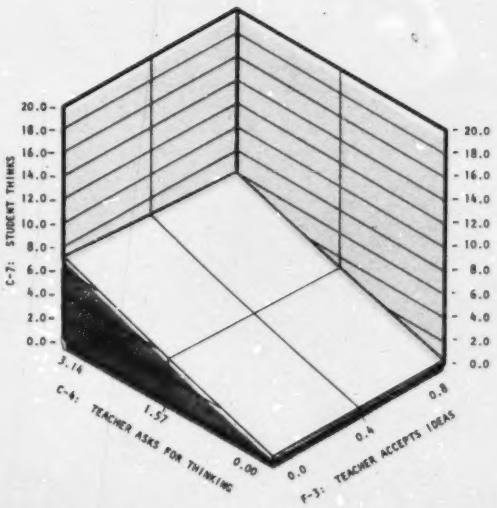


Fig. B: SP = 2.6

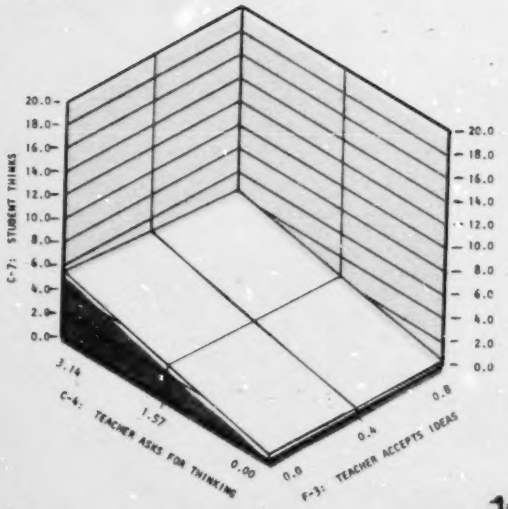


Fig. C: SP = 2.8

C-7: STUDENT THINKS (SEC.) (02)

$$C\text{-}7 = 0.85695 + 1.9448F3 + 1.6452C4 - 0.0602F1F1$$

$\underline{F} = 20.265$

$R^2 = 0.521$

$s_E = 3.328$

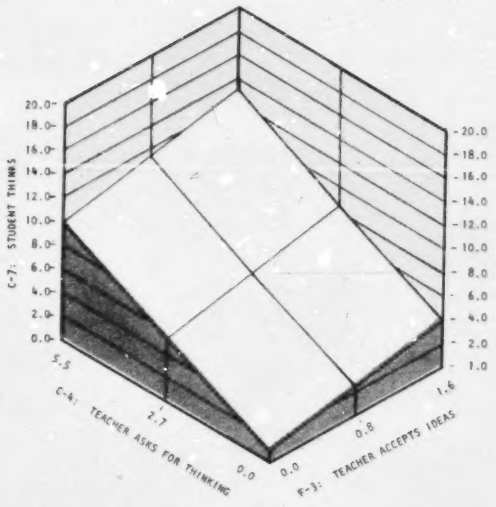


Fig. A: F-1 = 0.0

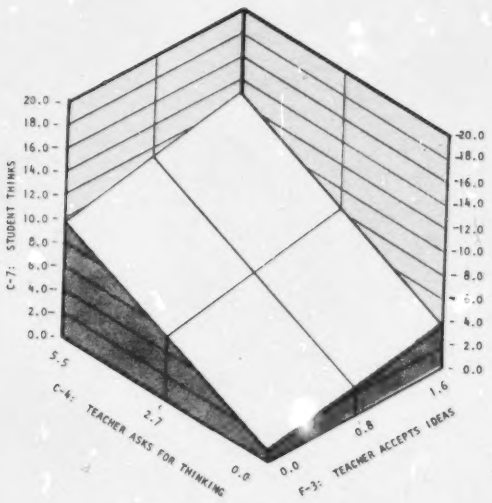


Fig. B: F-1 = 1.34

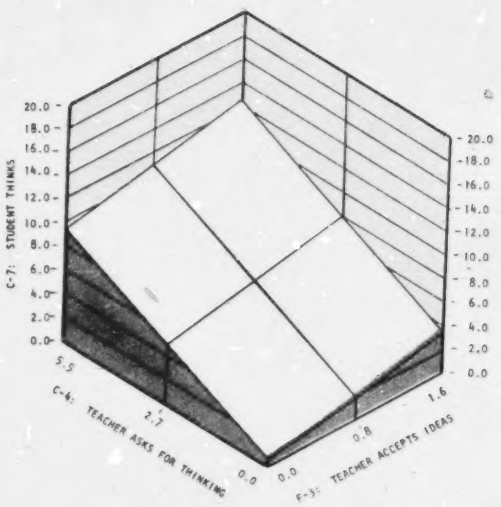


Fig: C: F-1 = 2.7

C-8: STUDENT ASKS FOR THINKING (ELEM.) (02)

C-8 = 0.1303 - 0.4955F1C3 + 0.1029F1C4 + 0.4465C3C3

$\underline{F}$ = 100.641

R^2 = 0.760

s_E = 0.429

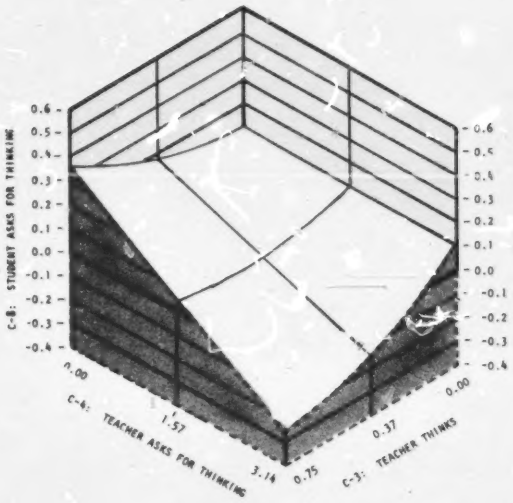


Fig. A: F-1=0.0

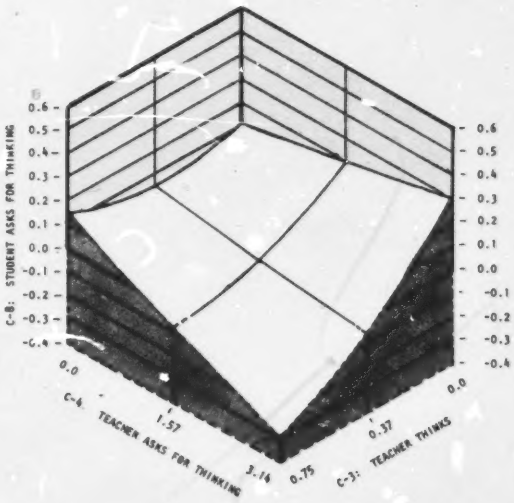


Fig. B: F-1=0.6

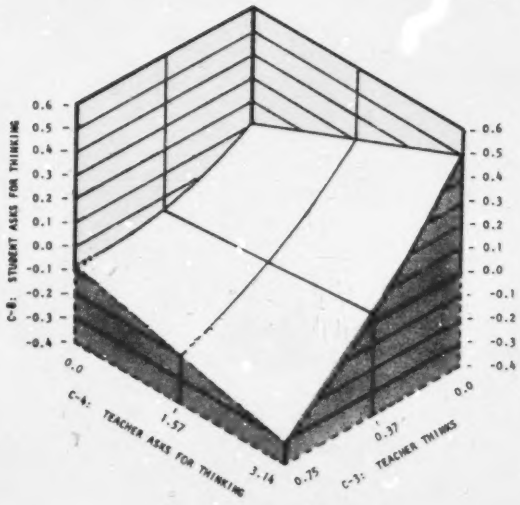


Fig. C: F-1=1.2

C-8: STUDENT ASKS FOR THINKING (SEC.) (02)

$$C\text{-}8 = -2.21217 + 1.645M + 0.052F1S1 - 0.027MS1$$

$\underline{F} = 8.221$

$R^2 = 0.306$

$s_E = 0.327$

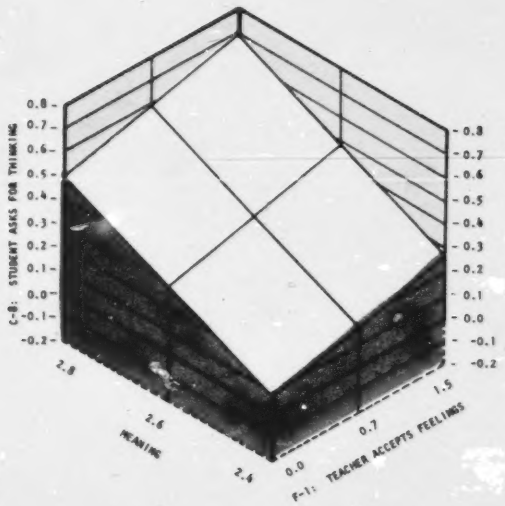


Fig. A: SI = 2.5

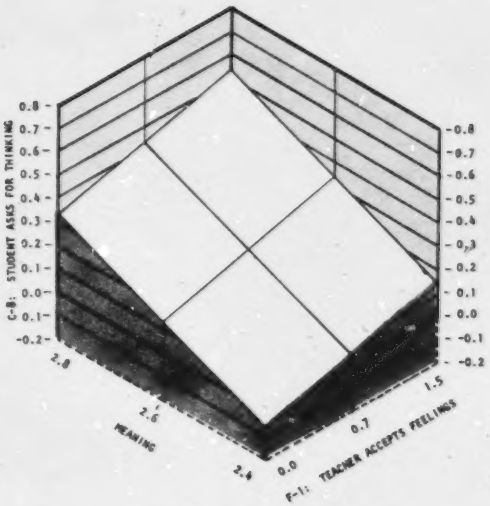


Fig. B: SI = 2.77

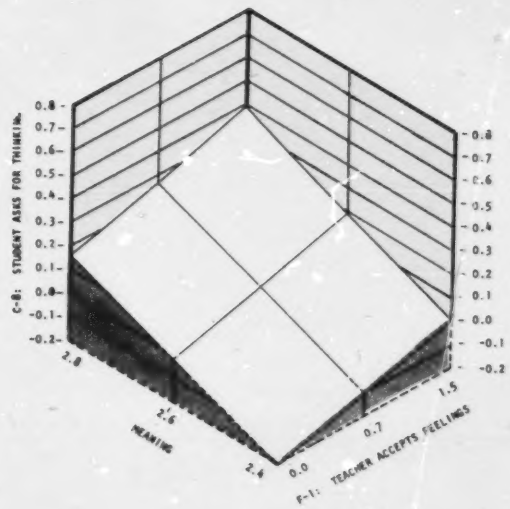


Fig. C: SI = 3.0

M: MEANING (ELEM.)

$$M = 2.69905 - .5514F2 - .1121C7 + 0.1994F2R + 0.0390C7R$$

$\underline{F} = 67.990$

$R^2 = 0.634$

$s_E = 0.133$

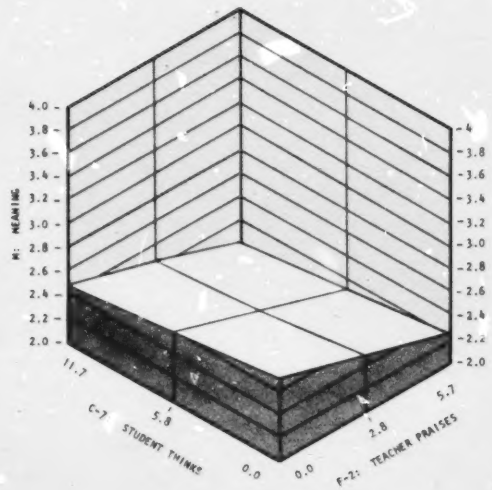


Fig. A: R = 2.4

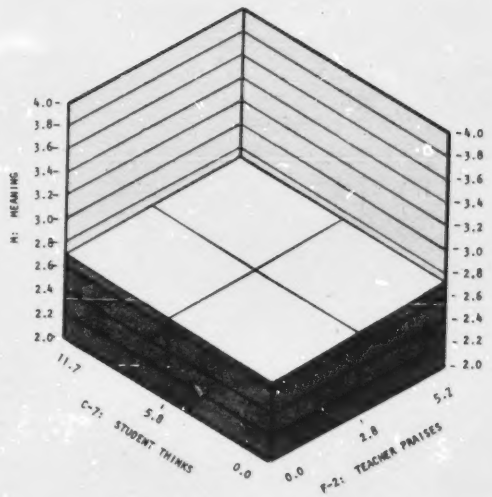


Fig. B: R = 2.8

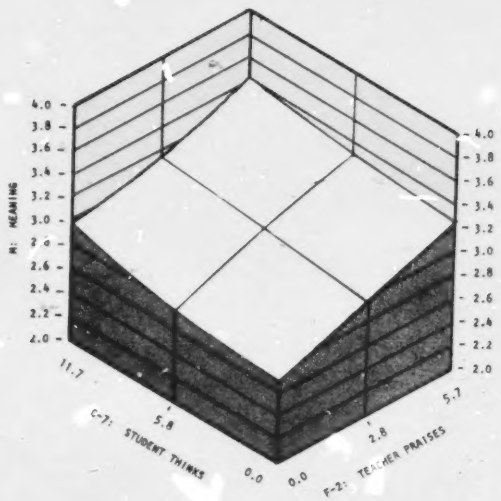


Fig. C: R = 3.2

MEANING (SEC.)

$$M = 0.143279 - 0.0686F3 + 0.0053C1 + 0.827R + 0.0005F3C1 - 0.00002C1C1$$

$\underline{F} = 83.17888$

$s_E = 0.095$

$R^2 = 0.818$

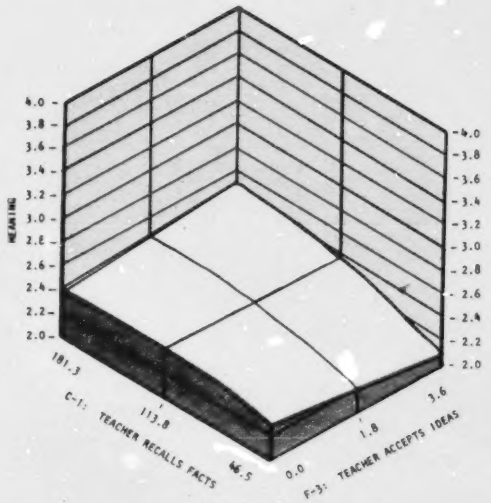


Fig. A: R = 2.3

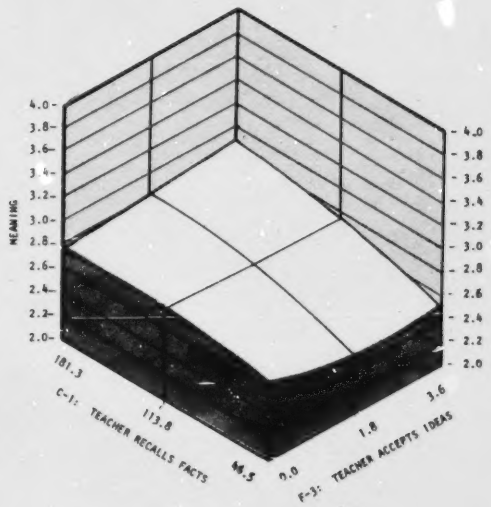


Fig. B: R = 2.8

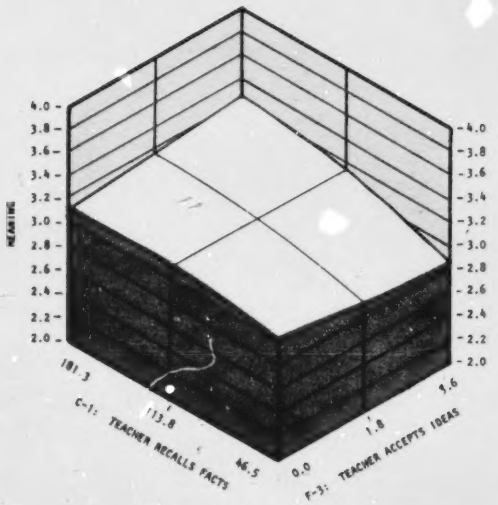


Fig. C: R = 3.2

SI: STUDENT INVOLVEMENT (ELEM.)

$$SI = 11.69696 + 6.207G - 5.578F1F1 + 0.744F1C7$$

$\underline{F} = 105.243$

$R^2 = 0.666$

$s_E = 1.088$

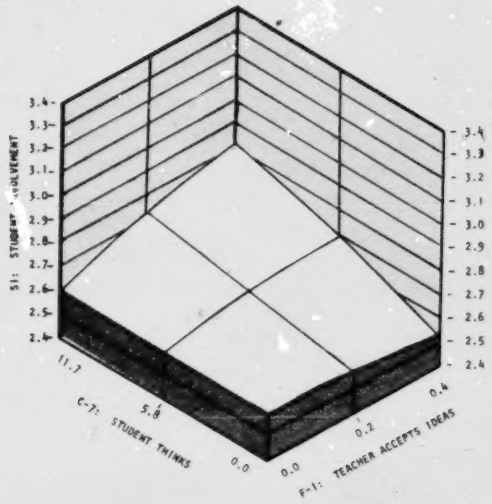


Fig. A: G=2.3

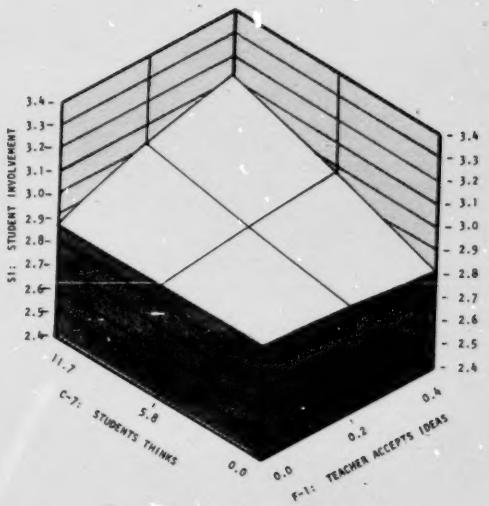


Fig. B: G=2.7

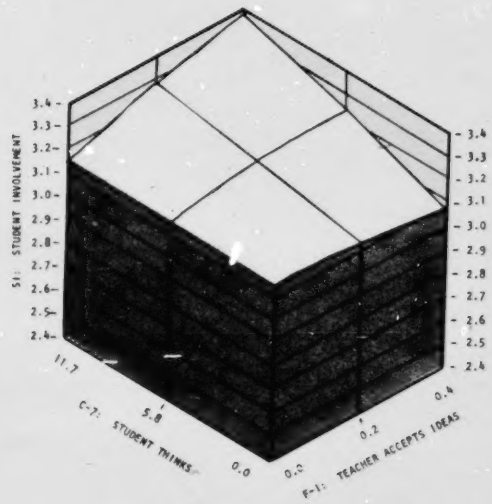


Fig. C: G=3.2

SI: STUDENT INVOLVEMENT (SEC.) (02)

$$SI = 1.83838 - 0.0602C2 - 0.0945C7 + 0.3341G + 0.0241C2G + 0.0355C7G$$

$\underline{F} = 47.376$

$R^2 = 0.814$

$s_E = 0.099$

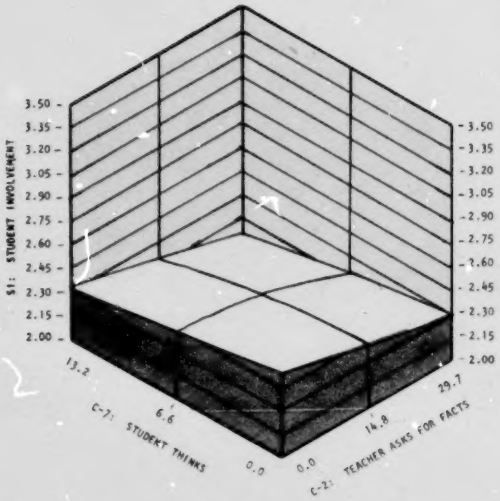


Fig. A: G=2.2

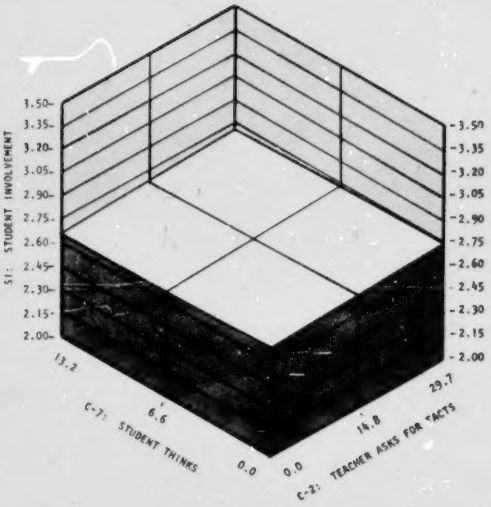


Fig. B: G=2.6

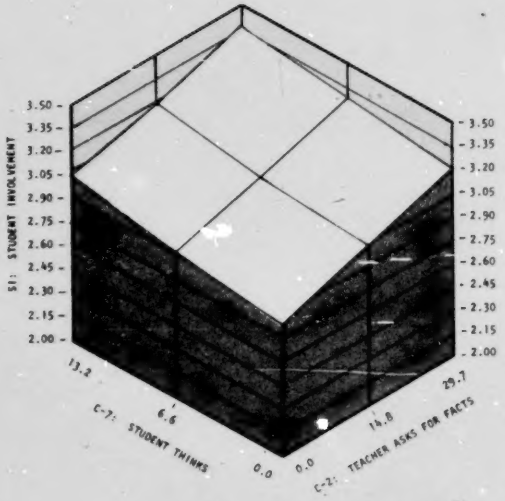


Fig. C: G=3.0